A DISSERTATION ON

"FUNCTIONAL AND RADIOLOGICAL OUTCOME OF PROXIMAL TIBIAL FRACTURES TYPE V AND TYPE VI TREATED BY MODIFIED HYBRID EXTERNAL FIXATOR"

Dissertation submitted to

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For the awards of the degree of

M.S. DEGREE BRANCH – II

ORTHOPAEDICS

MAY 2018

GOVERNMENT MOHAN KUMARAMANGALAM

MEDICAL COLLEGE, SALEM

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DECLARATION BY THE CANDIDATE

I solemnly declare that this dissertation ***"FUNCTIONAL AND RADIOLOGICAL OUTCOME OF PROXIMAL TIBIAL FRACTURES TYPE V AND TYPE VI TREATED BY MODIFIED HYBRID EXTERNAL FIXATOR" IN GOVERNMENT MOHAN KUMARAMANGALAM MEDICAL COLLEGE, SALEM*** *is a bonafide and genuine research work carried out by me under the guidance and supervision of* ***Prof Dr.T.M.MANOHAR, M.S.(Ortho), Professor,*** *Department of Orthopaedics, Government Mohan Kumaramangalam Medical College Hospital, Salem, Tamil Nadu, India.*

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Date : 19.10.17

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At the outset I thank the Lord, Almighty, for giving me the strength to perform all my duties.

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PLAGIARISM CERTIFICATE

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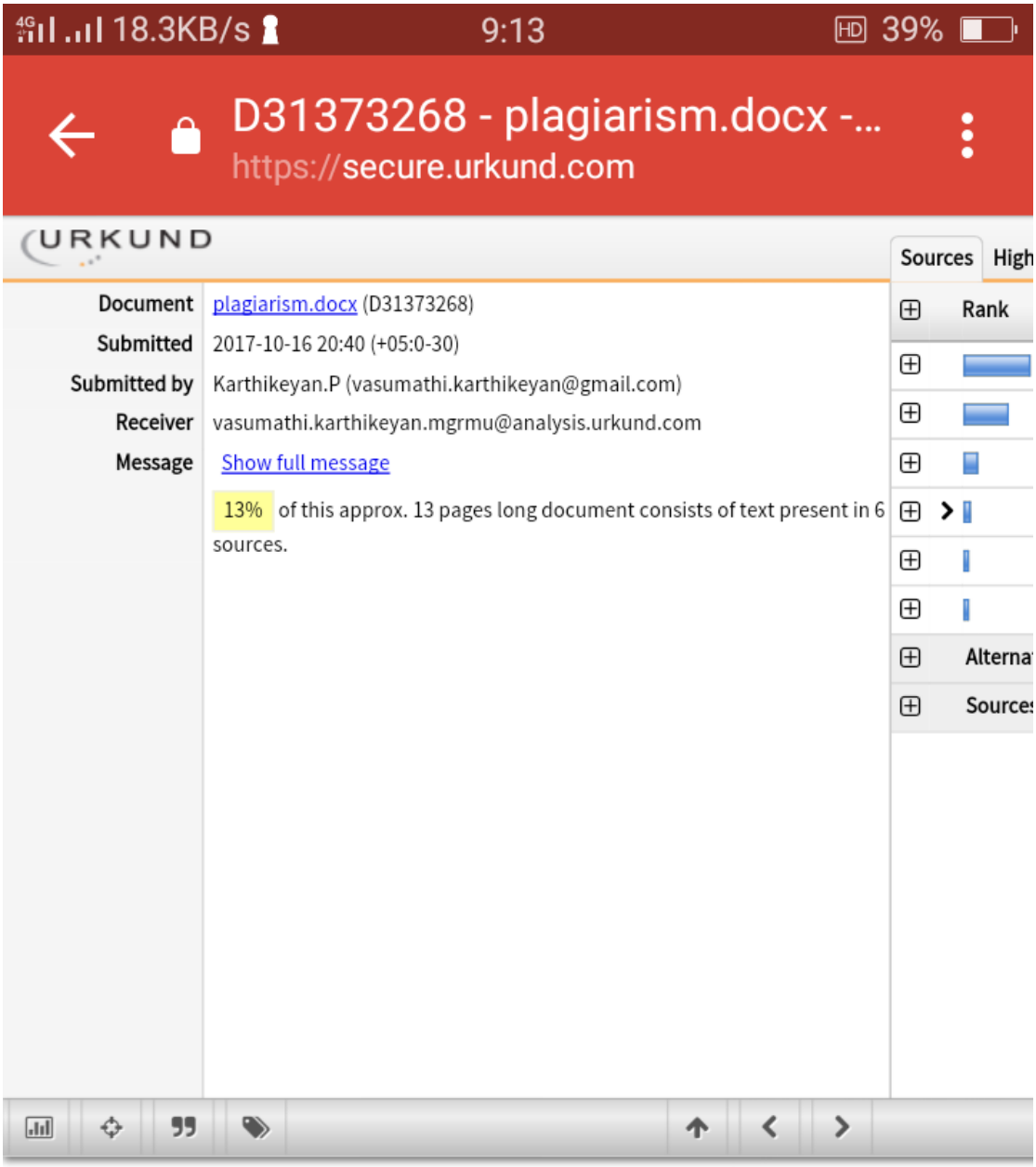

INTRODUCTION

Intraarticular fractures of the proximal end of tibia the so called tibial plateau fractures are serious complex injuries difficult to treat(9) not only because of their fracture patterns, but also their nature of injury.

These fractures are mostly due to high energy injuries and often associated with soft tissue injuries.

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Ethical Committee Meeting held on 23.12.2015 at 11.00 A.M in the Seminar Hall, IInd Floor, Medicine Block, Govt. Mohan Kumaramangalam Medical College Hospital, Salem 01.

Name of the Presenter with Address	Title	Name of the Guide and Address	Whether it is Approved or not.
Dr. P. Karthikeyan, I Year, Post Graduate Student of MS (Orthopaedics), GMKMC, Salem-30.	"Functional and Rediological outcome of Proximal Tibial Fracture treated by modified hybrid external fixator in 20 patients."	Dr. T.M. Manohar, MS., Associate Professor of Orthopaedics, GMKMC, Salem.	Approved

The Ethical Committee examined the studies in detail and is pleased to accord Ethical Committee approval for the above Post Graduate student of this College to carry out the studies with the following conditions.

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2. He should inform the institution Ethical Committee in case of any change of study procedure site and investigation or guide.

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DEAN

To
The Individual.

LIST OF ABBREVIATIONS USED

AP	-	anteroposterior
LAT	-	lateral
BP	-	Bood pressure
CT	-	Computed tomography
CVS	-	Cardiovascular system
CNS	-	Central nervous system
ECG	-	electrocardiography
HbsAG	-	Hepatitis B surface antigen
HIV	-	Human immunodeficiency virus
IM	-	intramuscular
RR	-	Respiratory rate
RTA	-	Road traffic accident
TEMP	-	temperature
PR	-	Pulse rate
ROM	-	Range of movements
Pre op	-	preoperative
Post op	-	Postoperative

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ABSTRACT

INTRODUCTION:

Management of high energy tibial plateau fractures along with extensive soft tissue damage is still challenging to many orthopaedic surgeons.

AIM:

This study evaluates the purpose of hybrid external fixator in treating high energy tibial plateau fractures with minimal invasion and accurate reduction.

MATERIAL AND METHODS:

Twenty patients with high energy schatzker type V and VI tibial plateau fractures with severe soft tissue injury were enrolled into the study.

RESULTS:

The results - bony union, range of movements and associated complications – were assessed. All fractures were united in an average time period of 20 weeks.Two patients developed knee stiffness and one septic non-union.

CONCLUSION:

Hybrid external fixation is a safe option for managing complex high energy tibial plateau fractures by simultaneously providing adequate fracture stabilization and necessary protection to soft tissue healing to achieve bony union.

Key words : Hybrid external fixator, High energy tibial plateau fractures,

INTRODUCTION

Intraarticular fractures of the proximal end of tibia the so called tibial plateau fractures are serious complex injuries difficult to treat[9] not only because of their fracture patterns, but also their nature of injury.

These fractures are mostly due to high energy injuries and often associated with soft tissue injuries.

Even though various modalities of management offered to these fractures, the management is still challenging and confusing to most of the orthopaedic surgeons today.

Over the years, many proposed treatment modalities, from simple traction to demanding surgery, presented fair results, but also serious complications.

The amount of energy involved at the time of injury determines the severity of the tibial plateau fractures. Complex fracture patterns with comminution and extensive soft tissue involvement seen in high energy trauma.

Goals of treatment in such high energy tibial plateau fractures are to maintain joint stability, articular congruity and alignment without much soft tissue dissection thereby helping in early mobilisation of knee joint.

Various modalities of treatment available are

- Conservative management
- Plate fixation
  - Open method
  - MIPO method
- External fixation

- Hybrid external fixation
- Ring fixation

Modified Hybrid external fixation has recently been advocated. It relies on periarticular ring construct for stable fixation of tibial condyles and monolateral fixator for fixation on the shaft to provide stable fixation.

This study highlights the technique and results of treatments using this modified hybrid external fixation for such injuries.

REVIEW OF LITERATURE

The tibial plateau is one of the most critical load bearing areas in the human body.the fractures of tibial plateau affect knee alignment, stability and motion.

Tibial plateau fractures constitute 1% of all fractures.

Tibial plateau is defined as the smooth bony surface of either the lateral condyle or the medial condyle of the tibia that articulates with the corresponding condylar surface of the femur.

Sir Astley Cooper first described fracturesof the proximal tibia in 1825.

Anger treated most minimally displaced fractures with early knee traction mobilisation[(1)].

Rasmussen introduced open reduction and internal fixation of tibial condylar fractures[(2)].

Sarmiento popularized functional cast bracing of most tibial condylar fractures[(3)].

Watson et al applies the term hybrid fixation quite loosely by stating that hybrid fixation denotes no single or universally accepted treatment strategy or device[(14).]

Kumar and Paige differentiate conventional Ilizarov frame from hybrid ilizarov frame by using schanz pins rather than wires through the distal ring for fixation of the diaphysis[15].

With the evolution of technique and hardware used, the current hybrid frame consists of small tensioned wires on a proximal ring frame to maintain and reduce the metaphyseal fragments, while the remainder of the distal frame is attached to the shaft using standard external fixator's half pins[30].

SURGICAL ANATOMY OF TIBIAL PLATEAU AND LEG

TIBIAL PLATEAU

The knee is a complex joint exposed to forces that can exceed five times the weight of the body. The joint has enhanced mobility at the cost ofstability.

The proximal tibia expands from the diaphysis through a metaphyseal flare. Contact is made with the head of fibula in the posterolateral quadrant. The surface of the tibial plateau has a medial and a lateral weightbearing portion and an intercondylar eminence.

The medial plateau is generally larger than the lateral plateau. It’s superior surface articulates with the medial condyle of femur. The articular surface is oval and it’s long axis is anteroposterior.

The central part of the articular surface is slightly concave. The flatter peripheral part separated from the femoral condyle by the medial meniscus. The lateral margin of the articular surface is raised to cover the medial intercondylar tubercle.

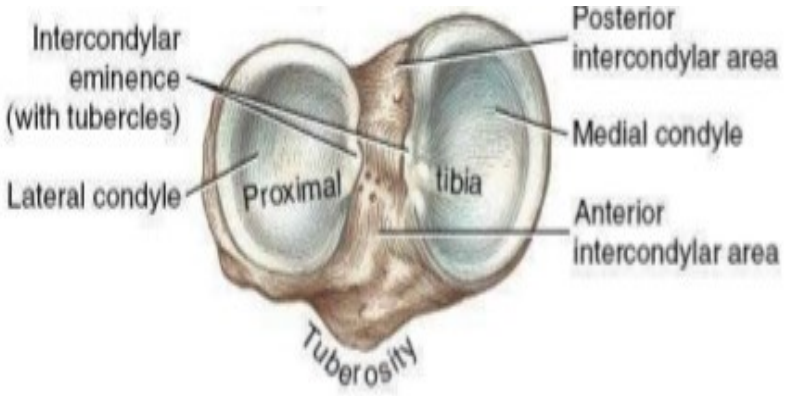
The lateral plateau articular surface is nearly circular, and it articulates with lateral condyle of femur. The central part is slightly concave and the peripheral part is covered by lateral meniscus. The

articular surface has a raised medial margin which covers the lateral intercondylar tubercle.

The posteroinferior aspect bears a flat, circular fibular facet and is directed downwards, backwards, laterally.this facet articulates with fibula.

The intercondylar eminence is both nonarticular and nonweight bearing. It provides attachment to medial and lateral menisci and the anterior and posterior cruciate ligaments.

The tibial tuberosity is situated on the anterior surface of proximal tibia inferior to condyles. Lower down the tibial tuberosity is continuous with the anterior border of the shaft.


Intercondylar eminence (with tubercles)
Lateral condyle
Proximal
tibia
Posterior intercondylar area
Medial condyle
Anterior intercondylar area
Tuberosity


Anterior View of Knee
Femur
Patella
Lateral condyle
Lateral meniscus
Head of fibula
Fibula
Tibia
Medial condyle
Posterior cruciate ligament
Medial meniscus
Anterior cruciate ligament
Superior View of Tibial Plateau
Head of fibula
Posterior cruciate ligament
Medial meniscus
Lateral meniscus
Tibia
Anterior cruciate ligament

ANATOMY OF SHAFT OF TIBIA

Tibial shaft is prismoid in shape and has three borders (anterior, medial and interosseus), and three surfaces (lateral, medial and posterior)

BORDERS:

The anterior border is sharp and S shaped (convex medially in the upper part and convex laterally in the lower part) that extends from the tibial tuberosity to the anterior border of medial malleolus. Anterior border is subcutaneous and forms the shin.

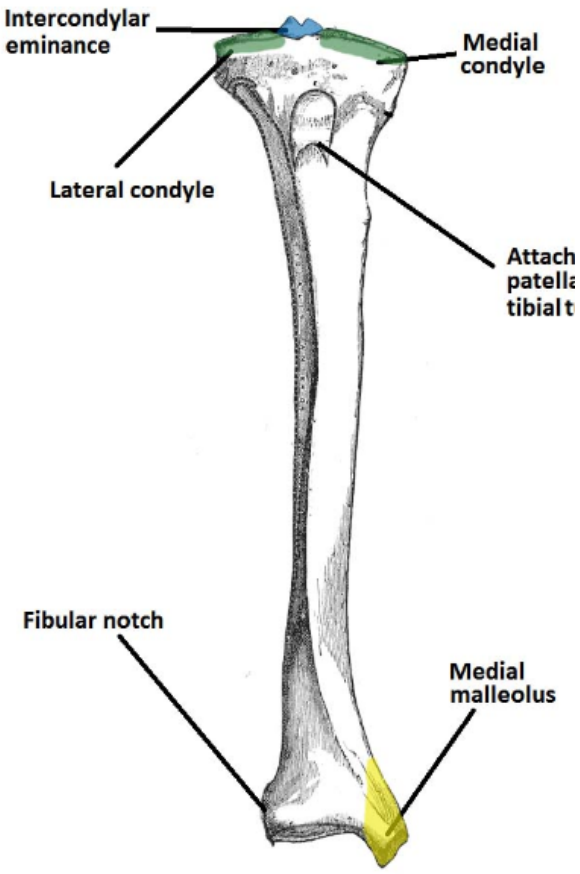
The medial border extends from the medial condyle above to the posterior border of medial malleolus and is rounded.

The lateral border is also called interosseus border and extends from the lateral condyle to the anterior border of fibular notch.

SURFACES:

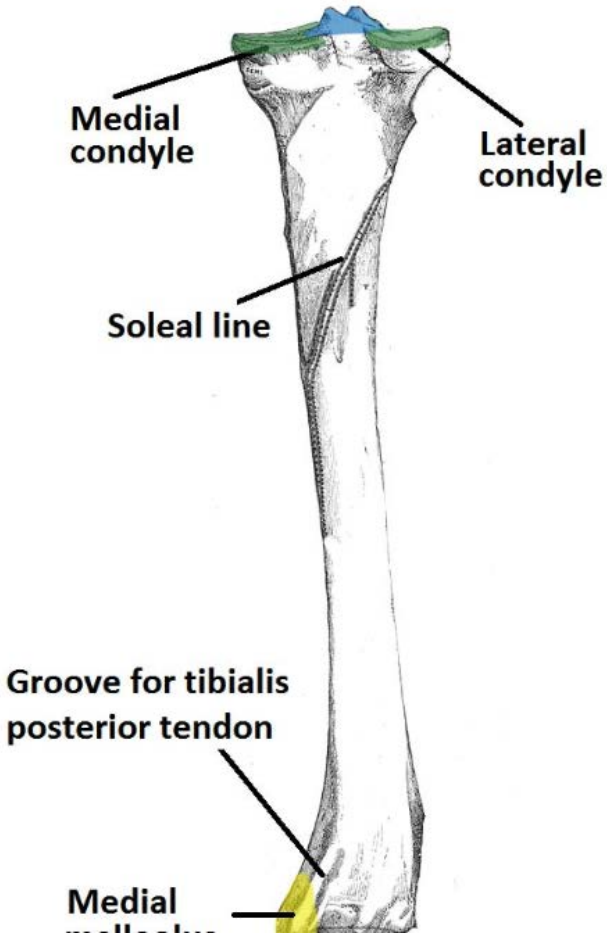
The medial surface lies between the anterior and interosseus borders. It is mostly subcutaneous (upper three fourths).

The lateral surface lies between the anterior and interosseus borders. In it’s upper three fourths, it is concave and directed laterally and in lower one fourth, it is directed forwards.



The posterior surface lies between the medial and interosseus borders. It is widest in it’s upper part. A rough ridge called soleal line crosses it here extending from the fibular facet, running downwards and medially, and terminating by joining the medial border at the junction of upper and middle thirds.

Above the soleal line, the posterior surface is in the form of triangular area whereas the area below the soleal line is elongated and divided into medial and lateral partsby a vertical ridgewhich harbours downward directed nutrient foramen.



ATTACHMENTS ON THE TIBIA

UPPER END OF TIBIA

MEDIAL CONDYLE:

The upper border-capsular ligament of the knee joint and deeper fibres of the tibial collateral ligament

Groove on the posterior surface- semimembranous

Anterior surface- medial patellar retinaculum

LATERAL CONDYLE:

Flattened impression on the anterior surface- the iliotibial tract.

Margins of the fibular facet- the capsular ligament of the superior tibiofibular ligament.

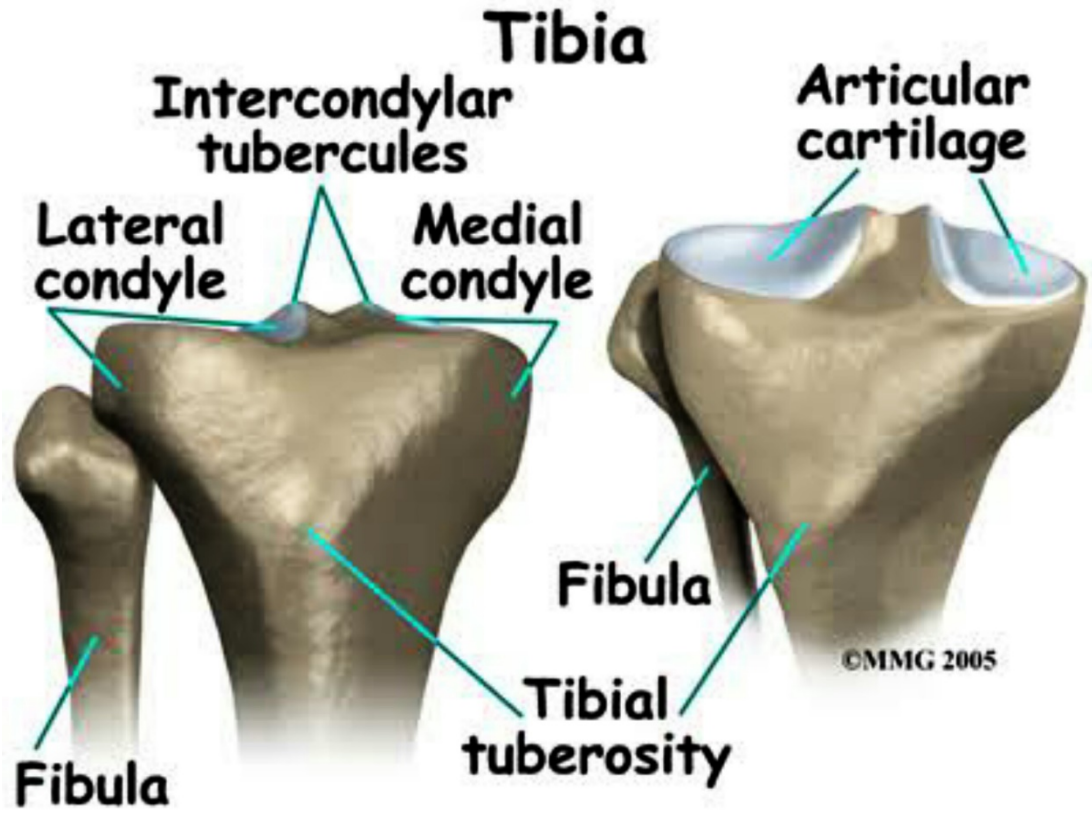
Near the fibular facet- the origin of fibres of extensor digitorum longus and of the peroneus longus.

Groove on the posterior surface of the lateral condyle- tendon of popliteus with an intervening bursa.

INTERCONDYLAR AREA:

Intercondylar area is the roughened area on the superior surface , between the articular surfaces of the two condyles. The area is narrowest

in its middle part. This part is elevated to from the intercondylar eminence which is flanked by the medial and lateral intercondylar tubercles.



SHAFT:

Upper two thirds of lateral surface – tibalis anterior origin

Upper part of the medial surface – Sartorius, gracillis and the semitendinosus insertions, tibial collateral ligament

Soleal line-

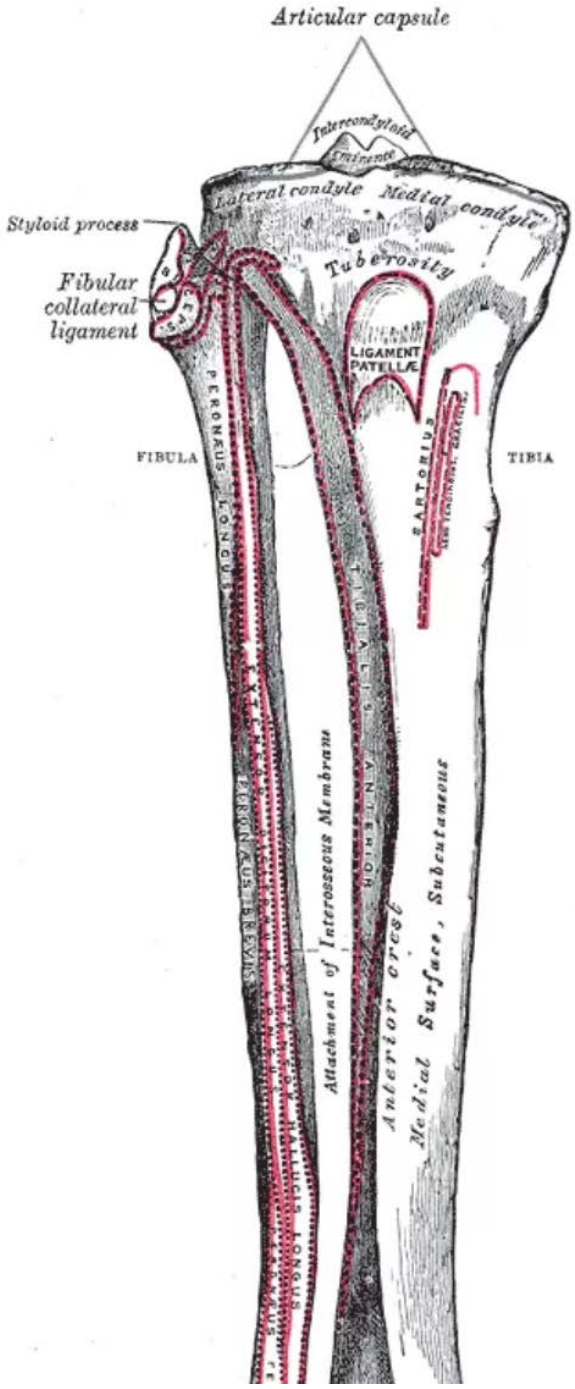
1. The soleus muscle
2. Fascia covering the soleus
3. Fascia covering the popliteus
4. Transverse fascial septum
5. Above the soleal line – popliteus insertion
6. Below the soleal line –

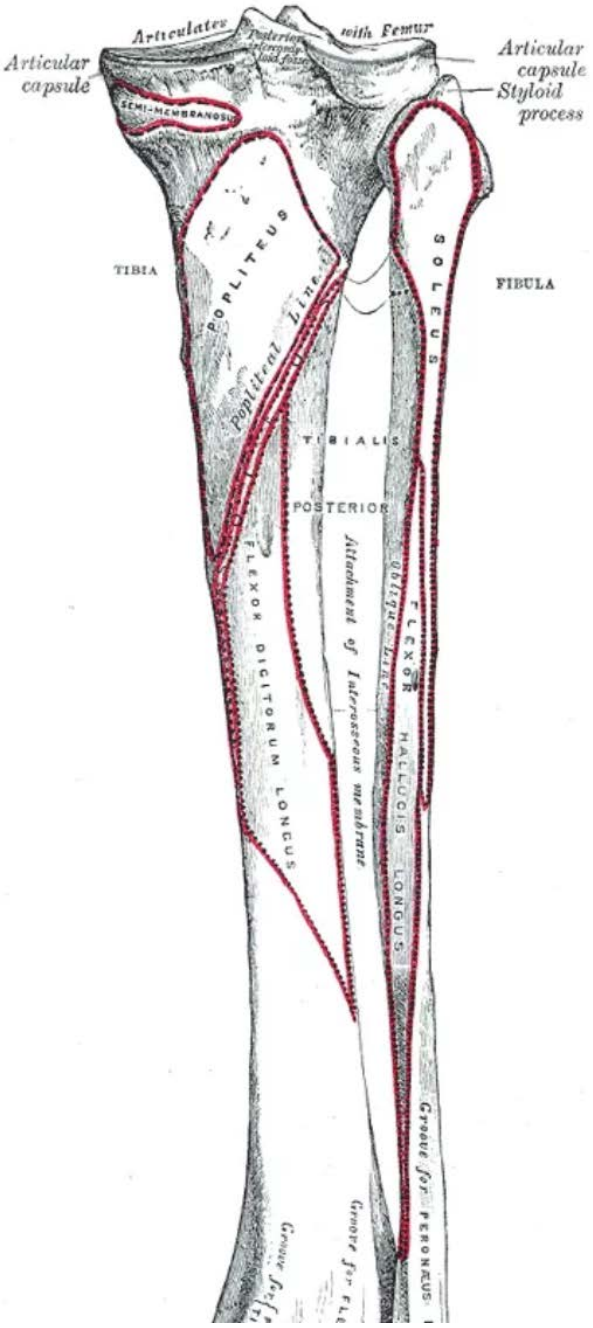
Medial area- flexor digitorumprofundus origin

Lateral area – tibialis posterior origin

Anterior border of tibia- deep fascia of leg and superior extensor retinaculum.

The interosseous border- interosseous membrane


Articular capsule
Intercondyloid eminence
Lateral condyle
Medial condyle
Tuberosity
Styloid process
Fibular collateral ligament
LIGAMENT PATELLÆ
FIBULA
TIBIA
PERONÆUS LONGUS
TIBIALIS ANTERIOR
SARTORIUS
Attachment of Interosseous Membrane
Anterior crest
Medial Surface, Subcutaneous


Articulates with Femur
Articular capsule
Articular capsule
Styloid process
SEMI-MEMBRANOSUS
TIBIA
FIBULA
POPLITEUS
Popliteal Line
SOLEUS
TIBIALIS POSTERIOR
FLEXOR DIGITORUM LONGUS
Attachment of Interosseous membrane
FLEXOR HALLUCIS LONGUS
Groove for PERONEUS

COMPARTMENTS OF LEG

ANTERIOR COMPARTMENT OF LEG

Muscles;

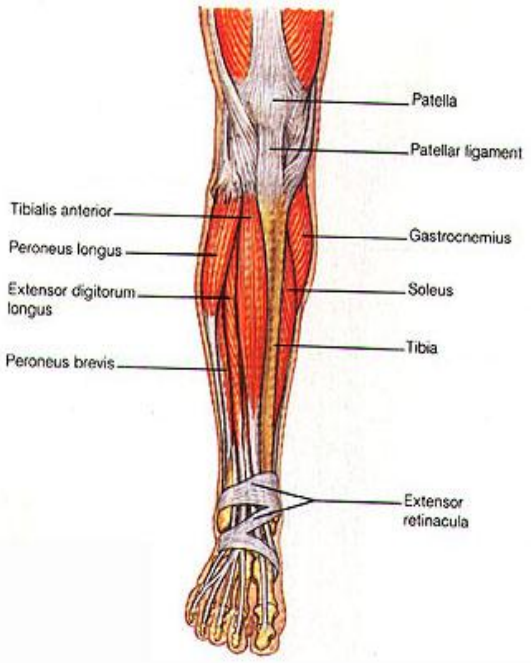
- Tibialis anterior
- Extensor digitorum longus
- Extensor hallucis longus
- peroneus brevis

Blood supply;

- Anterior tibial artery

Nerve supply;

- Deep peroneal nerve



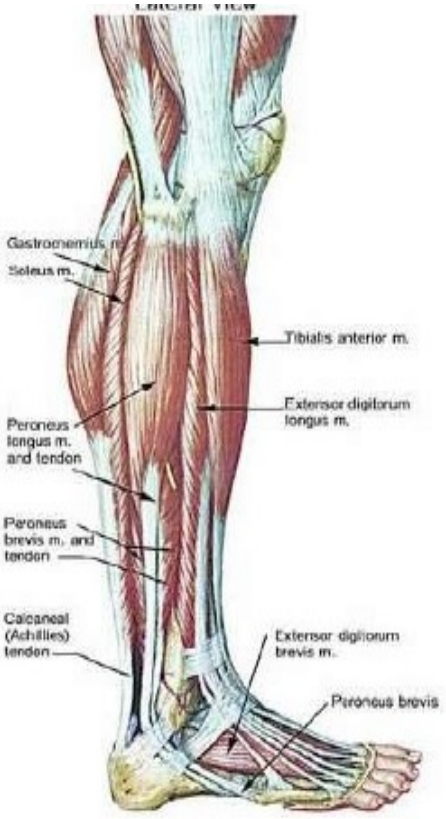
LATERAL COMPARTMENT OF LEG

Muscles;

- Peroneus longus
- Peroneus brevis

Nerve supply;

- Superficial peroneal nerve



POSTERIOR COMPARTMENT OF LEG

It is the largest of the three compartments and contains seven muscles , organised into two layers separated by a band of fascia

Superficial muscle layer;

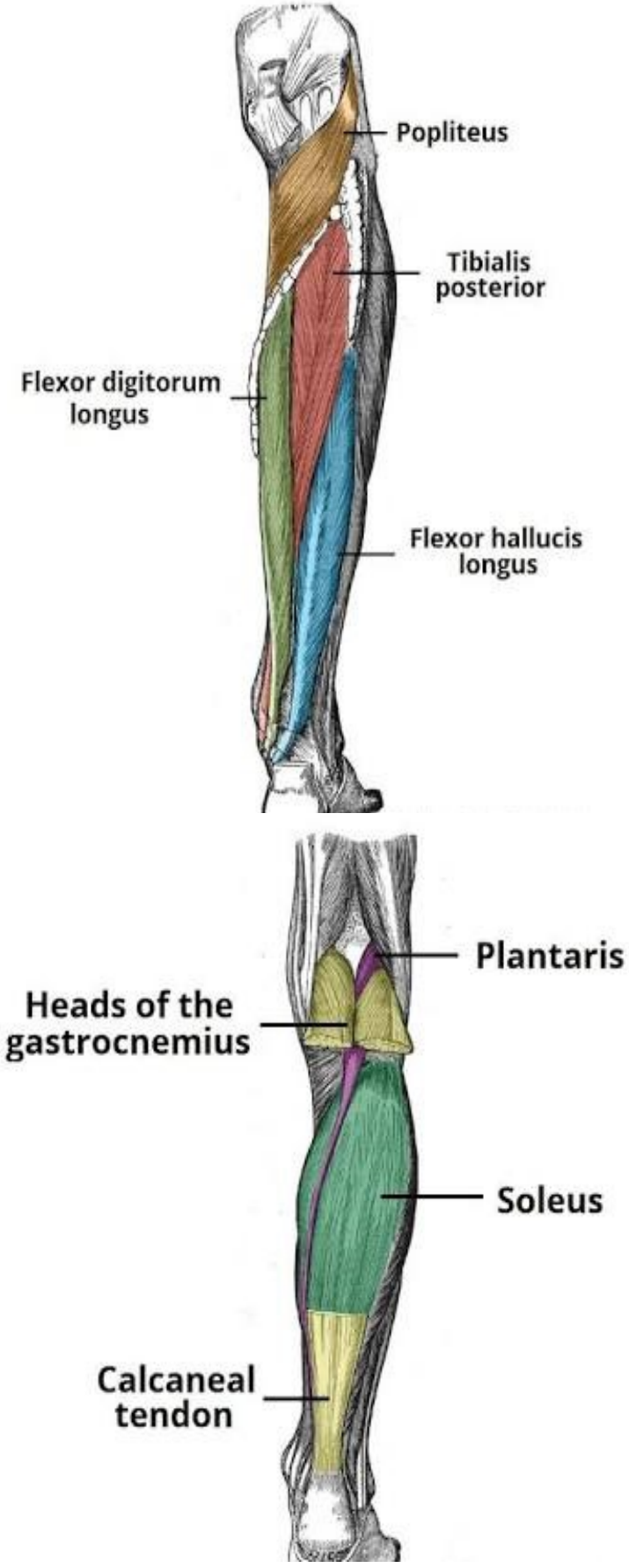
- Gastrocnemius
- Soleus
- Plantaris

Deep muscle layer;

- Popliteus
- Tibialis posterior
- Flexor digitorum longus
- Flexor hallucis longus

Nerve supply;

- Tibial nerve


Popliteus
Tibialis posterior
Flexor digitorum longus
Flexor hallucis longus
Plantaris
Heads of the gastrocnemius
Soleus
Calcaneal tendon

ANATOMY OF THE LEG VESSELS

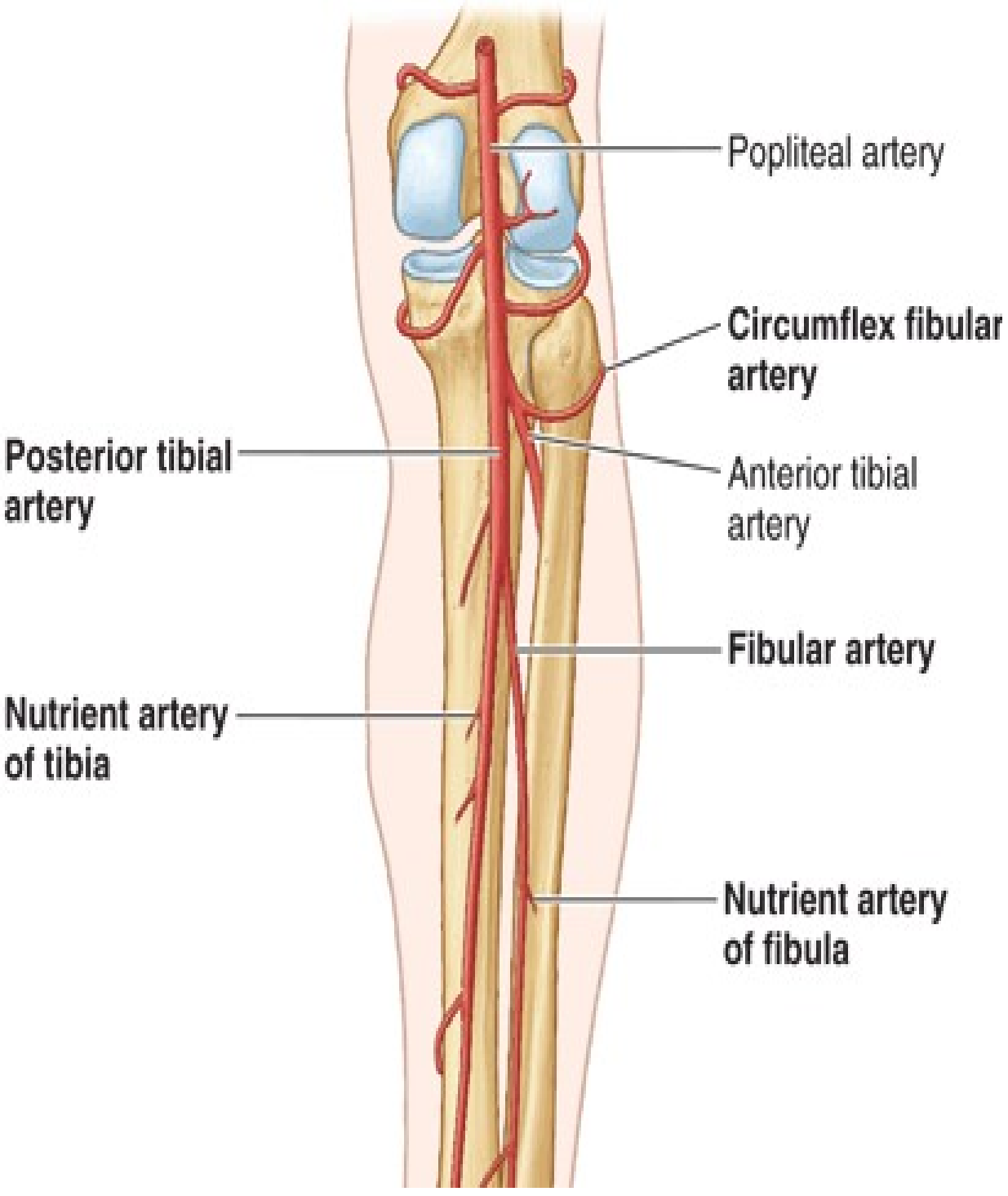
POPLITEAL ARTERY:

- Continuation of the femoral artery at adductor hiatus
- Runs through the popliteal fossa
- Gives the following branches

1. Medial superior genicular artery
2. Lateral superior genicular artery
3. Medial inferior genicular artery
4. Lateral inferior genicular artery

At the lower end of the popliteus, it divides into

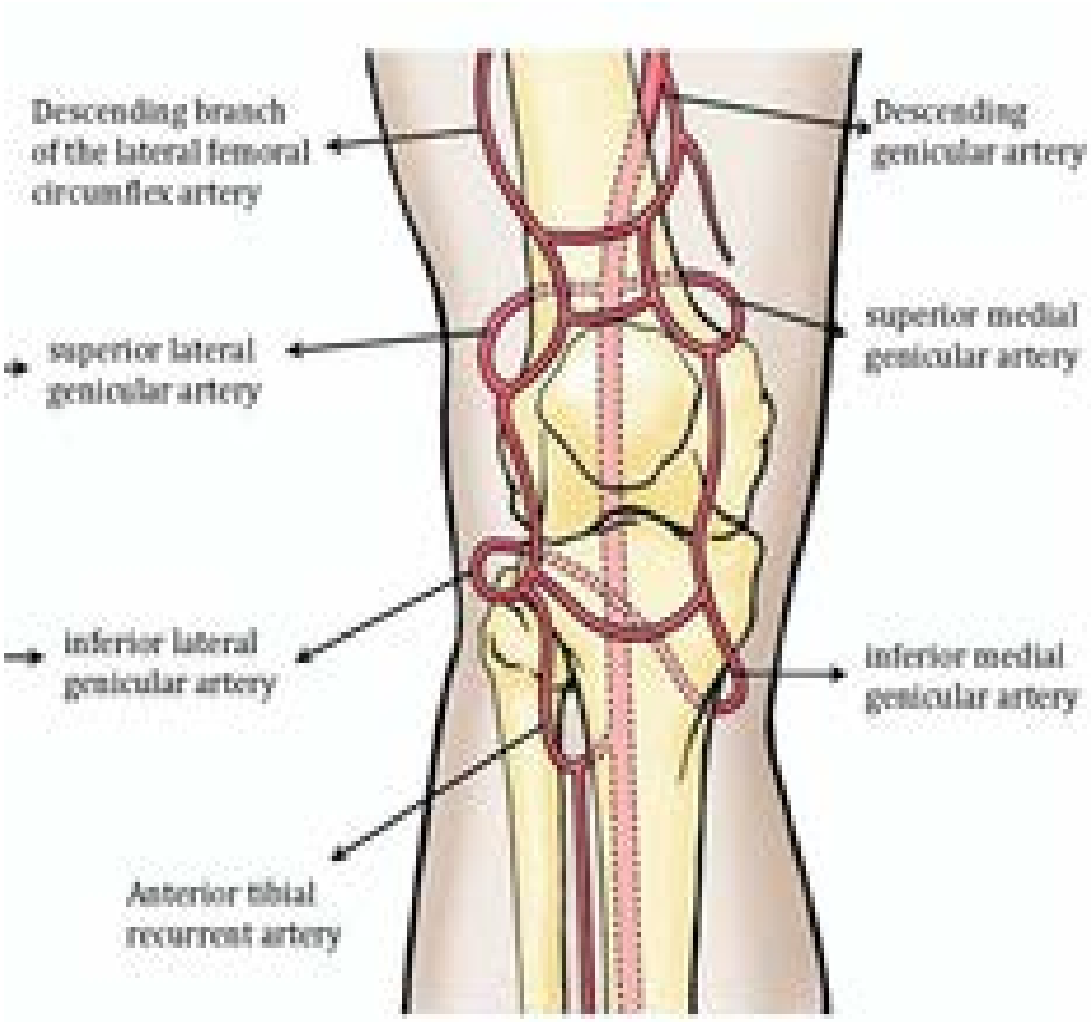
- Anterior tibial artery
- Posterior tibial artery which gives the peroneal artery


Popliteal artery
Circumflex fibular artery
Posterior tibial artery
Anterior tibial artery
Fibular artery
Nutrient artery of tibia
Nutrient artery of fibula

ANASTOMOSIS AROUND THE KNEE JOINT

Is made by the following branches

- Descending branch of lateral circumflex femoral
- Descending genicular of femoral
- Anterior tibial recurrent
- Five branches of popliteal artery

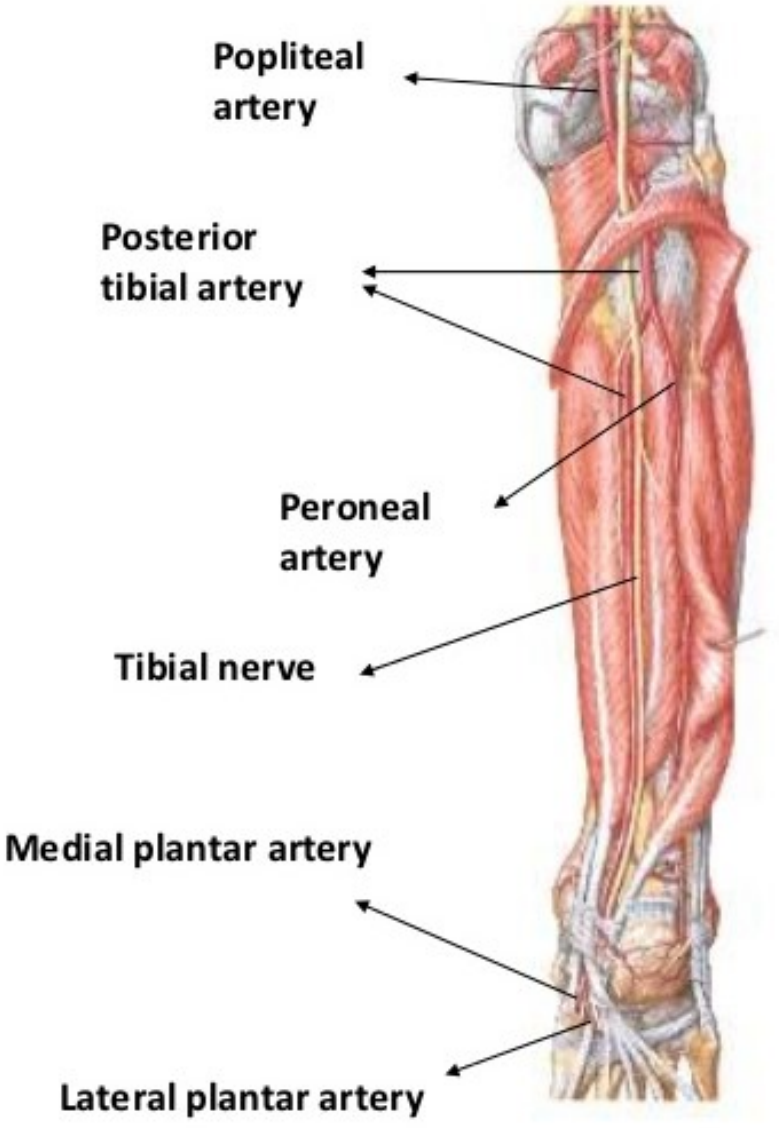


ANTERIOR TIBIAL ARTERY:

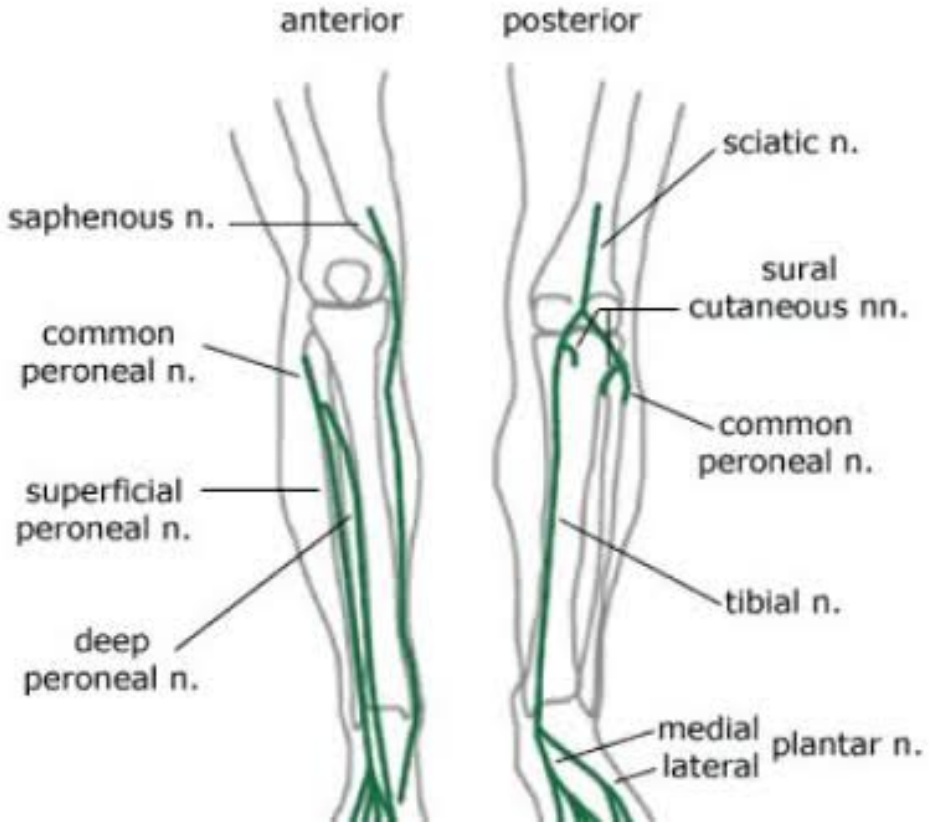
- Supplies all structures in the anterior compartment of leg and perforating branches to lateral compartment
- Ends at the midpoint between the malleoli
- Continues as Dorsalispedis artery

POSTERIOR TIBIAL ARTERY:

- Supplies all structures in the posterior and lateral compartment of leg
- Runs behind and inferior to the medial malleolus
- Divides into medial and lateral plantar branches

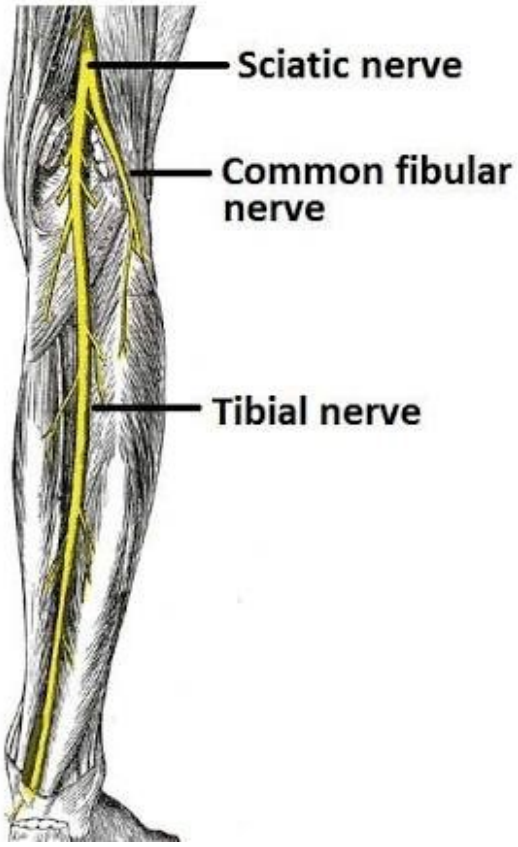


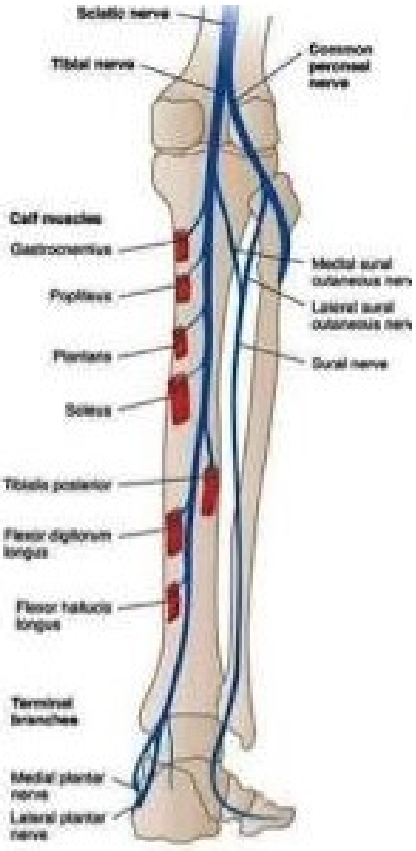
NERVES OF LEG



TIBIAL NERVE:

It is the larger of the two terminal branches of sciatic nerve. It nearly bisects the popliteal fossa , from the upper angle to the lower angle.It leaves the fossa at the lower border of popliteus muscle, where it continues in the posterior compartment of leg, as the posterior tibial nerve and passes between the superficial and deep muscles of the posterior compartment of leg.


Sciatic nerve
Common fibular nerve
Tibial nerve


Sciatic nerve
Tibial nerve
Common peroneal nerve
Calf muscles
Gastrocnemius
Popliteus
Plantaris
Soleus
Tibialis posterior
Flexor digitorum longus
Flexor hallucis longus
Terminal branches
Medial plantar nerve
Lateral plantar nerve
Medial sural cutaneous nerve
Lateral sural cutaneous nerve
Sural nerve

COMMON PERONEAL NERVE:

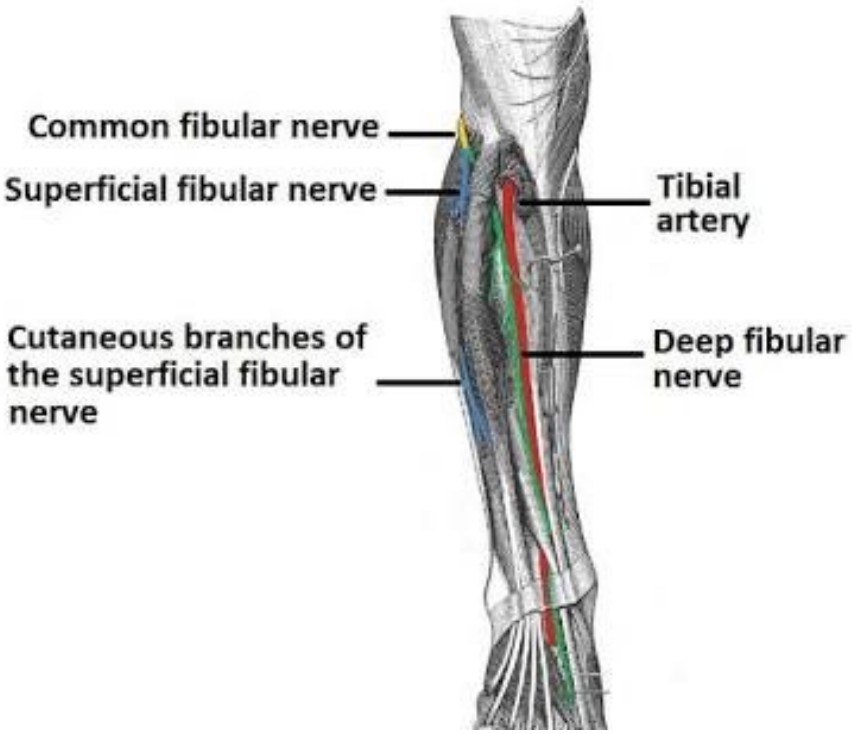
It is the smaller of the two terminal branches of sciatic nerve.

It passes downwards and laterally along the medial border of biceps to the lateral angle of popliteal fossa.

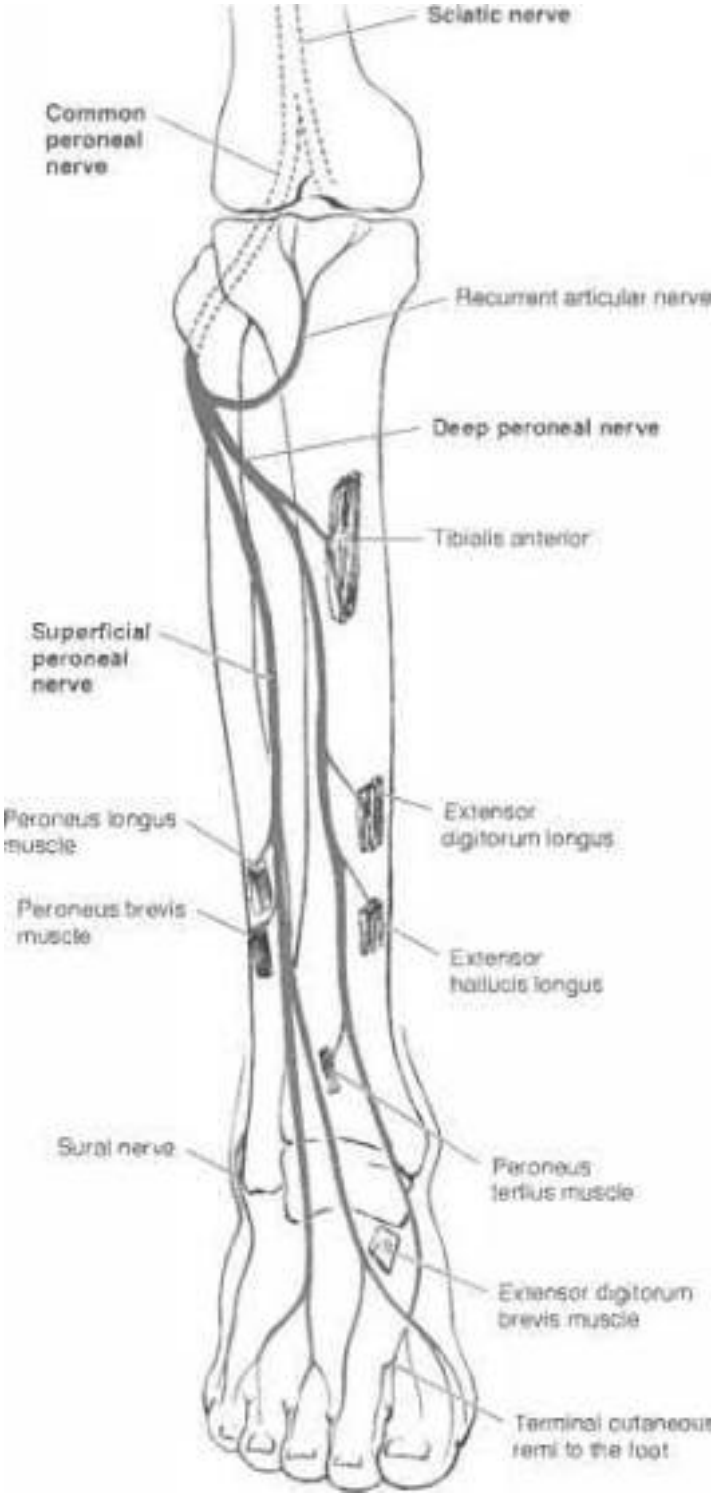
It curves forwards lateral to the neck of fibula.

It pierces peroneus longus , then divides into two terminal branches,

- Superficial peroneal nerve- supplies lateral compartment



- Deep peroneal nerve - supplies anterior compartment


Sciatic nerve
Common peroneal nerve
Recurrent articular nerve
Deep peroneal nerve
Tibialis anterior
Superficial peroneal nerve
Peroneus longus muscle
Extensor digitorum longus
Peroneus brevis muscle
Extensor hallucis longus
Sural nerve
Peroneus tertius muscle
Extensor digitorum brevis muscle
Terminal cutaneous
rami to the foot

MECHANISM OF INJURY

Tibial plateau fractures are caused by a varus or valgus force combined with axial loading on knee. The tibial condyle is crushed or split by the opposing femoral condyle, which remains intact.

The medial plateau is larger and significantly stronger than the lateral plateau. Also the natural valgus alignment of the limb coupled with valgus force on impact will injure the lateral side.

The medial plateau is more resistant to fracture due to stronger thicker subchondral bone. Any fracture of medial plateau indicates high energy, high incidence of soft tissue complications and poor outcomes.

Tibial plateau fractures may be either low energy or high energy. Low energy fractures occur in osteoporotic bone and typically they are depressed fractures. High energy fractures are often due to RTA and most common pattern is splitting fracture.

CLASSIFICATIONS

There have been many classifications of tibial plateau fractures[4] of which the following are probably the most historically significant.

In 1900, Muller proposed a classification system for tibial plateau fractures according to the amount of articular involvement.

Hohl and Luck proposed a classification of plateau fractures that included nondisplaced, local depression, split depression and splitting fractures[5].

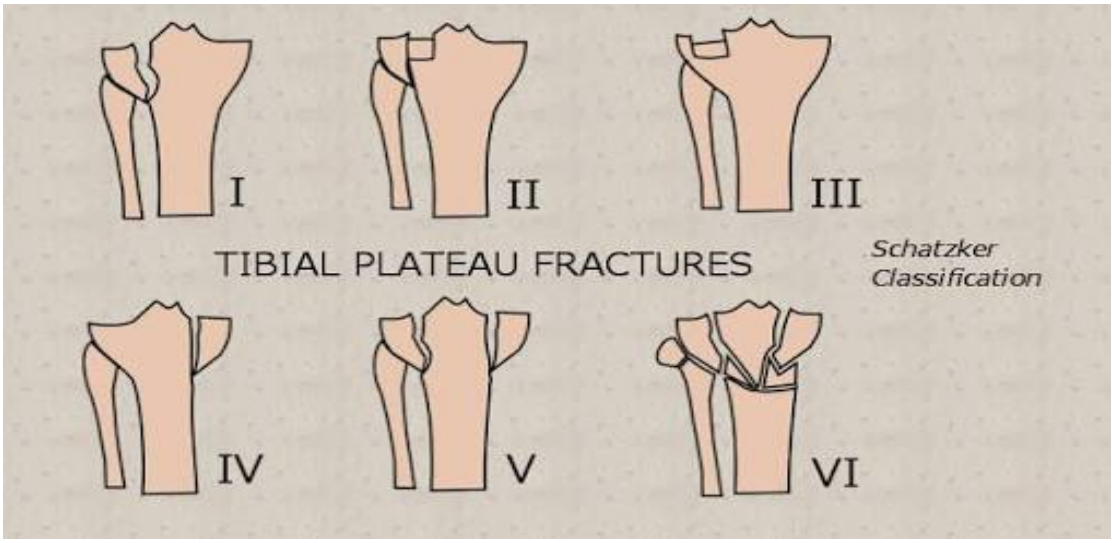
Hohl later expanded the classification to include comminuted fractures[6].

In 1981, Moore proposed a classification for fracture dislocation of the tibial condyle that took into consideration of soft tissue injury[7].

Schatzker et al proposed a classification system condyle fractures based on the fracture pattern and fragment anatomy. This classification system, which is widely accepted and used today, divides these fractures into the following six types[8]:

1. Split fracture
2. Split depression fracture
3. Pure depression fracture

4. Medial plateau fracture
5. Bicondylar fracture
6. Plateau fracture associated with metaphysealdiaphyseal dissociation



PATHOPHYSIOLOGY

TYPE I:

This is wedge or split fracture of the lateral plateau, usually as a result of valgus and axial forces; the wedge fragment is not depressed, because the underlying cancellousbone is strong; this pattern is usually seen in younger patients.

TYPE II:

This is a lateral wedge or split fracture associated with compression; the mechanism of injury is similar to that of a type I fracture, but the underlying bone may be osteoporotic and unabe to resist depression or the force may have been greater.

TYPE III:

This is a pure compression fracture of the lateral plateau; as a result of an axial force, the depression is usually located laterally or centrally, but it may involve any portion of the articular surface

TYPE IV:

This fracture involves the medial plateau; as a result of either varus or axial compression forces, the pattern may be either split alone or split with depression; because this fracture involves the larger and stronger

medial plateau , the forces causing this type are generally greater than those associated with types I,II, or III

TYPE V:

This fracture includes split elements of both the medial and lateral condyles and may include medial or lateral articular compression usually as a result of a pure axial force occurring while the knee is in extention

TYPE VI:

This is a complex bicondylar fracture in which the condylar components separate from the diaphysis; depression and impaction of fracture fragments are the rule.

SAFE ZONES FOR PIN INSERTION

Safe zones refers to placement of thin wires so as to avoid neurovasacular structures and intrasynovial placement to minimise the possibility of septic arthritis.

PROXIMAL TIBIA

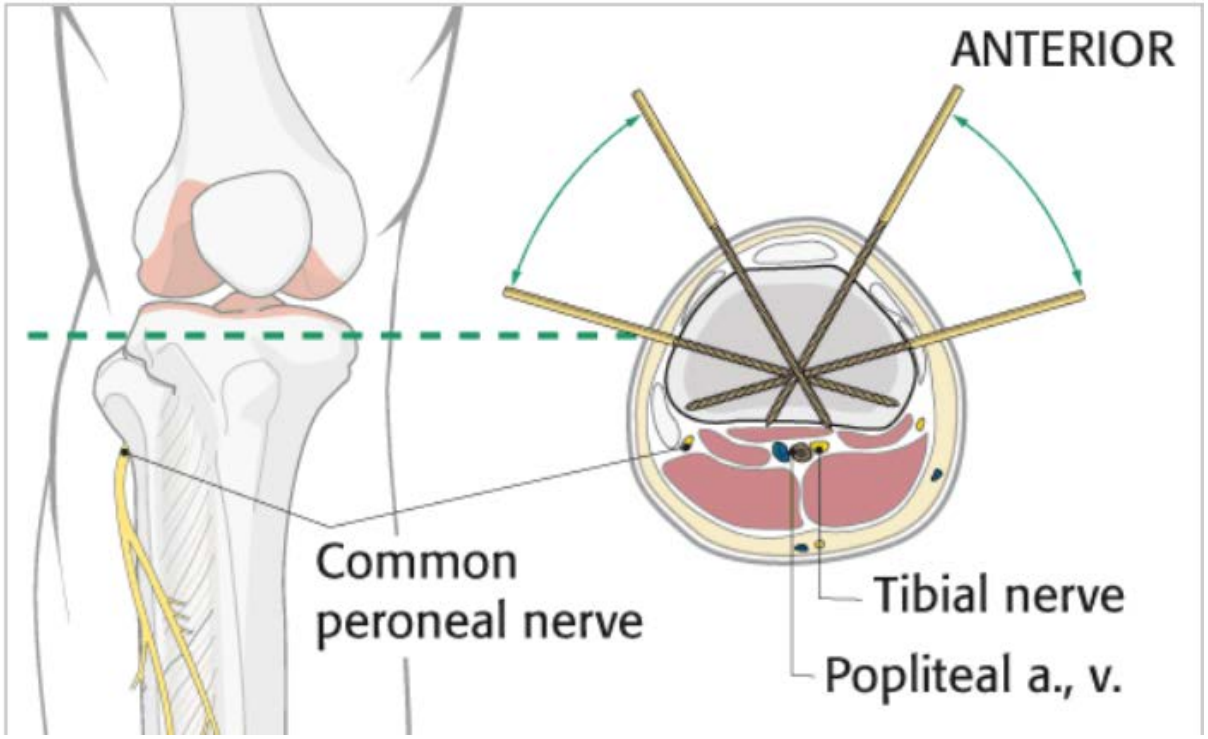
PROXIMAL TIBIAL HEAD:

NEUROVASCULAR STRUCTURES:

In the depth of the popliteal fossa, the neurovascular structures are in close proximity to the bone.

KNEE JOINT CAPSULE:

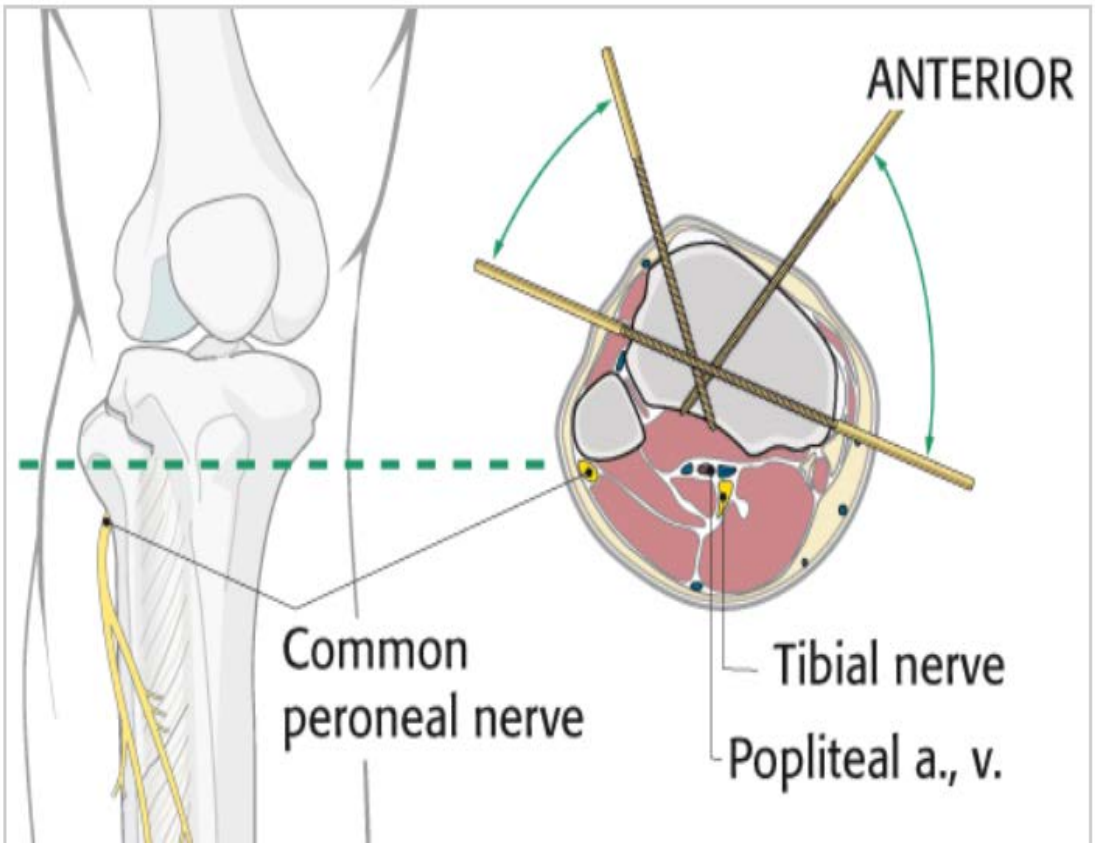
Pin placement should be 2 cm below the tibial plateau. If a more proximal pin fixation is necessary for very high fractures, pin placement should be as anterior as possible due to shorter extend of knee joint capsule in this area.


ANTERIOR
Common
peroneal nerve
Tibial nerve
Popliteal a., v.

TIBIOFIBULAR JOINT:

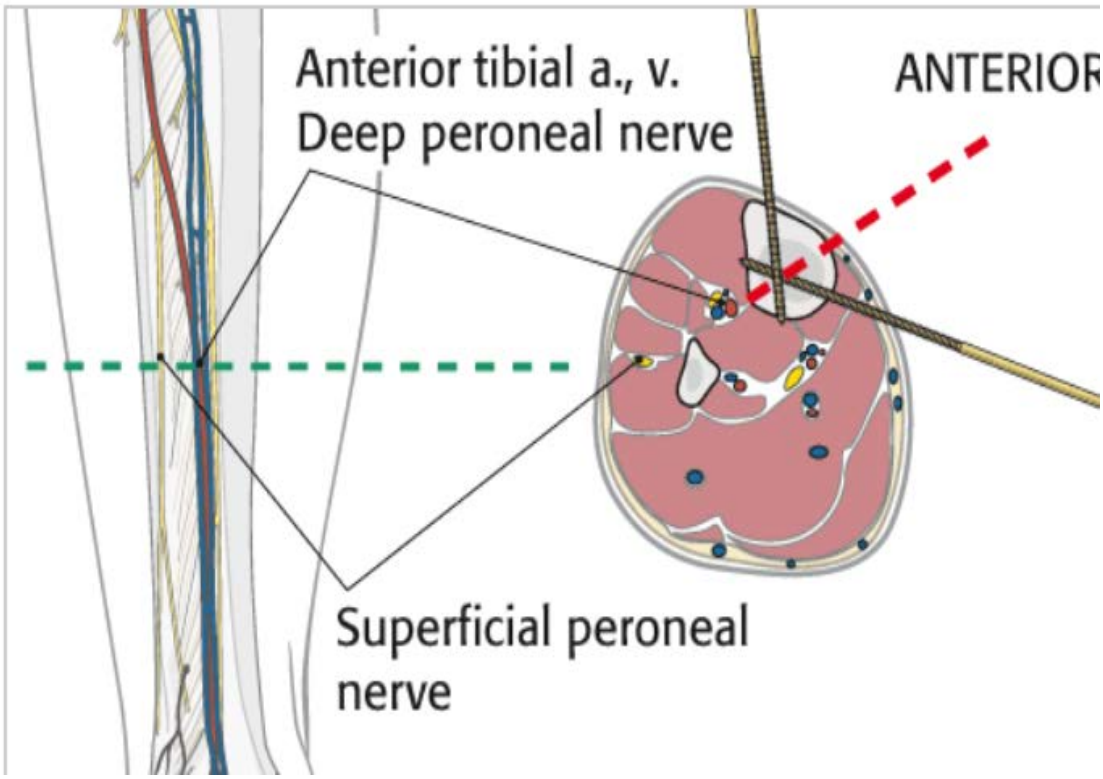
The common peroneal nerve winds around the fibular neck and then runs anteriorly and distally.

At the level of fibular head, both sides of patellar ligament and medial and lateral zones of tibia are safe zones.

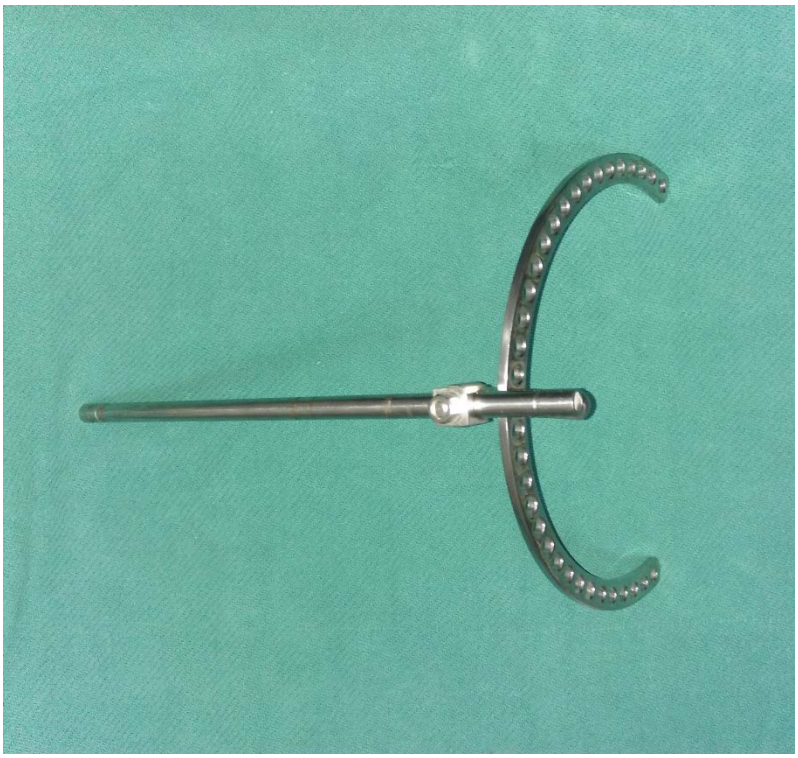


TIBIAL SHAFT:

The neurovascular bundle (the anterior tibial artery and vein together with the deep peroneal nerve) run anterior to the interrosseous membrane close to the posterolateral border of the tibia.



COMPONENTS OF HYBRID EXTERNAL FIXATOR



I.PRIMARY COMPONENTS:

The primary components are standard parts that join the skeleton to the finished frame, such as

- Transosseouswires
- Rings
- Wire fixation bolts

II.SECONDARY COMPONENTS:

The secondary components are the special elements used to construct the frame of the apparatus, such as rods, posts, nuts and bolts.

WIRE FIXATION BOLTS :

a) **Cannulated wire fixation bolt** :

Below the oblong head (10 mm small diameter), the bolt contains a longitudinal hole to fix the wires to the rings. The wire is passed through the concentric hole which is at thebase of the bolt head and clamped to the adjacent surface with a tightened nut.

Cannulated wire fixation bolts are limited to the central location of holes, but compared to the sloted bolts, they allow greater clamping force.

b)Slotted wire fixation bolts:

The wire fixation slot is eccentric under the 10-millimeter bolt head and parallel to its long axis. The open edge is more versatile. Wires can be slide under the bolt from either side. The wires are fixed between the slot

at the base of the head of the bolt and the ring surface. Since most wires cross the ring holes eccentrically, these slotted bolts are more commonly used.

Wires must be tensioned to achieve stiffness for bone stability. The traditional technique of tensioning involves winding the wire around the neck of the bolt. By locking the bolt to the ring under moderate torque of the nut, the nut-bolt-wire combination can be rotated as a unit. By turning two wrenches simultaneously, tension is applied to the wire as it wraps around the perimeter of the bolt.

After sufficient tensioning the head of the bolt is held stationary and the nut is further tightened to secure the wire. This method of wire tensioning creates unintended forces in the bone by altering the original axis of the wire upto one or two millimetres. For this reason, mechanical tensioners are now more commonly used.

To obtain optimal stability each wire should be placed on top and bottom of each ring. By separating the wires by the five millimetre ring thickness, a coupled effect avoids torque of each bone segment fixed to the ring. Fixing the wires on both surfaces of the ring also prevents warping of the ring.

HINGE (MALE AND FEMALE):

Hinges are specilaized posts with a single hole, offset to interface each other with a bolt. Machined from stainless steel five millimetres wide and 20 millimeters high, they are made with either a male or female connecting ends.

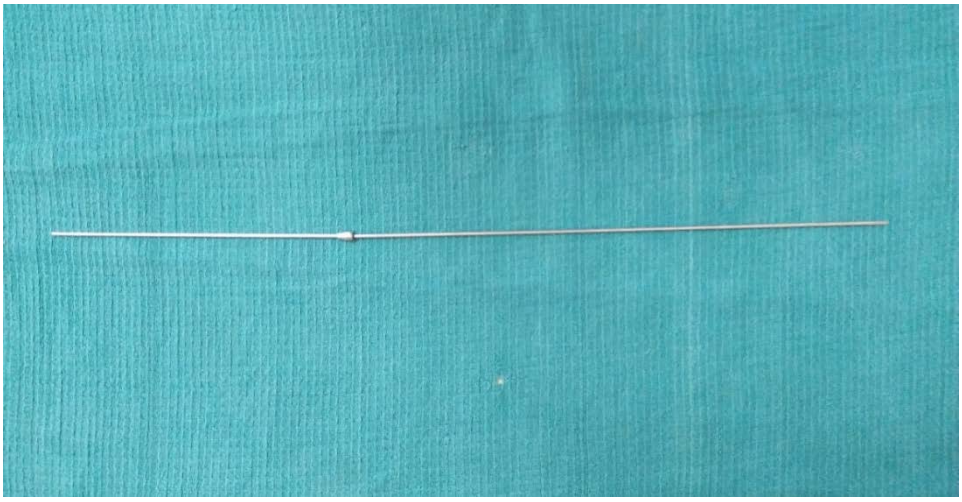
MALE HINGE FEMEALE HINGE

NUTS AND BOLTS:

These components are indispensable. The bolts are 10,16(or)30 millimeters in length. The head is 10 millimeters.

WIRE WITH STOPPER (OLIVE WIRE):

As one of Ilizarov's original concepts, these wire provide many special functions, such as interfragmentary compression, increasing stability ofthe construct (placed in opposite directions on opposite of bone, they increase the stability of frame construct and can be used to correct various deformities) gradual distraction or translation of bone fragments. For use in osteoporotic bone, a "stopper" with a larger surface area can be created by bending a normal transosseous wire into different configurations.



For example, in an oblique mid-shaft fracture, interfragmentary at the fracture site is accomplished by placing two olive wires in opposite direction using slotted, threaded rods to apply compression. In a malunion or non union of a forearm, olive wires provide a transverse force for correction while distraction is provided by the threaded rods. For intra-articular fractures, olive wires placed in opposite directions provide interfragmentary compression. In metaphyseal bone, an olive wire can be used with a washer for support.

DYNAMOMETRIC WIRE TENSIONER:

The tensioner is a very important instrument which allows one to tension the wires to an exact force,improving stability of the entire bone frame construct.

The wires should be tensioned from 50 to 130 kilograms. The exact amount of tensioning depend upon the weight of the patient, the local bone quality, treatment plan and the local frame construct. The wires can be retensioned or further tensioned during the treatment of the patient. To allow for this, the wire ends must be left long enough for the dynamometer to work (minimum of four centimeters)

The parts of dynamometer are

a. Handle for applying tension
b. Dynamometer scale from 50 to 130 kilos
c. Fixed jaw
d. Mobile jaw

STANDARD WIRE TENSIONER :

The wire is introduced into channel at the centre of the tensioner and then fixed with a bolt to the tensioner. The tensioner is then fixed to the ring to keep it from sliding about the ring. Turning the wing-nut clockwise applies tension to the wire.

INITIAL EVALUATION AND MANAGEMENT:

Full clinical assessment is required, including evaluation of the soft tissues to determine whether a compartment syndrome is present and the patient has sustained a neurovascular injury. Gentle stress testing can be performed with the leg in extension to evaluate the stability of the ligaments and to assess any sign of fracture displacement.

HISTORY:

After stabilisation of the patient's general condition, thorough history including the nature of injury, mode of injury was recorded. Mostly the fractures are caused by the strong force with the leg in varus or valgus or simultaneously vertical stress and flexion of the knee. The fractures are due to mostly car or motor accidents and sometimes sports accidents, mostly sports with a high velocity.

PHYSICAL EXAMINATION:

Careful thorough examination of the affected limb done including the extent of soft tissue injury, edema, contusion, neurovascular compromise, compartment syndrome.

Once the patient received, for closed fractures, the limb was well elevated to reduce the soft tissue edema and to prevent the compartment syndrome. Ice fomentation started.

The skin condition should be carefully examined for contusion, any discolouration, blisters.

Compartment syndrome signs like severe intense pain more than what would be expected from that injury itself, stretch pain, muscle tightness should be monitored carefully.

VARIOUS TREATMENT OPTIONS:

1. ORIF with plating or plating by MIPO
2. Intramedullary nailing
3. External fixation

COMPLICATIONS:

1. Nonunion
2. Malunion
3. Varus, valgus angulation
4. Neurovascular damage

METHODOLOGY

This is a prospective study conducted from June 2015 to September 2017.

20 patients with schatzker type 5 and 6 high energy tibial plateau fractures admitted in Government Mohan Kumaramangalam Medical College Hospital, Salem were included in the study after their valid informed written consent. Ethical committee approval obtained before the commencement of the study.

INCLUSION CRITERIA:

- Schatzker type 5 and 6 tibial plateau fractures
- Skeletally mature patients

EXCLUSION CRITERIA:

- Patients with tibial plateau fractures other than schatzker type 5 and 6
- Skeletally immature patients
- Patients who were medically unfit for surgery

The benefits and complications of all the available various treatment modalities for tibial plateau fractures were clearly explained to the patients before obtaining the consent.

OPERATIVE TECHNIQUE

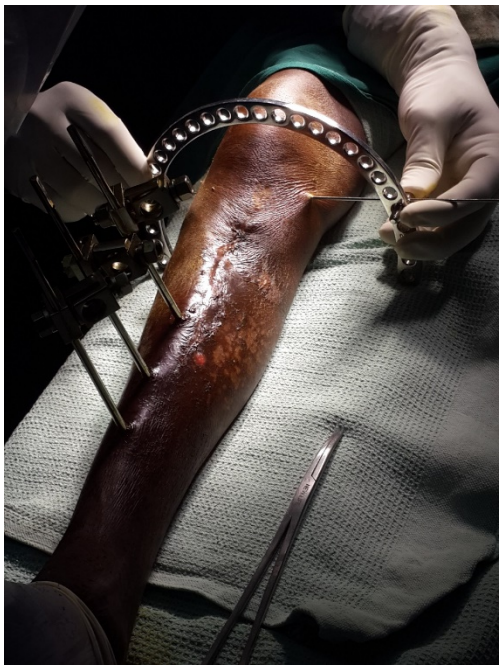
1.8mm / 2.0mm k wires introduced in the safe zone of proximal tibia, 15mm from the joint line, minimum angle between the two wires is 60 degrees. Placement of wires planned preoperatively according to fracture planes. Interfragmentary compression achieved using olive wires perpendicular to the fracture plane. If needed lag screws used to hold the reduction. Inaddition to the proximal ring and tensioned wires,one drop pin used in some cases to increase the stability of the proximal fragment. For articular fracture reduction a distractor or pointed reduction forceps used.

Insertion of wire:

Stab incision made and blunt dissection done down to the bone. Protection sleeves inserted until it reaches the bone. Under image

intensification, wires passed parallel to the knee joint until it penetrates the far cortex without impaling the tendons or neurovascular structures.

k wires attached to the ring , wires tensioned



Schanz pins inserted in the shaft

Schanz pins connected to external fixator rod, which was then coupled to the ring using the external fixator clamp after the correction of meta-diaphyseal alignment.

POSTOPERATIVE PROTOCOL

Daily thorough pin track care with immediate passive range of motion started on 1st POD. The patients were encouraged to start controlled knee movement as soon as possible. Patients were discharged from the hospital between 5th POD to 30th POD depending on their general condition and wound condition. Wound management was done with daily dressing, higher antibiotics according to pus culture and sensitivity, wound debridement on necessary basis and plastic surgery management for the patients who had loss of soft tissue.

Static quadriceps strengthening exercises, knee mobilisation exercises, seated knee extension exercises and nonweight bearing walking with walker were started on 2nd-3rd POD.

Partial weight bearing was started from 6 to 10 weeks depending on radiographic appearance of callus.

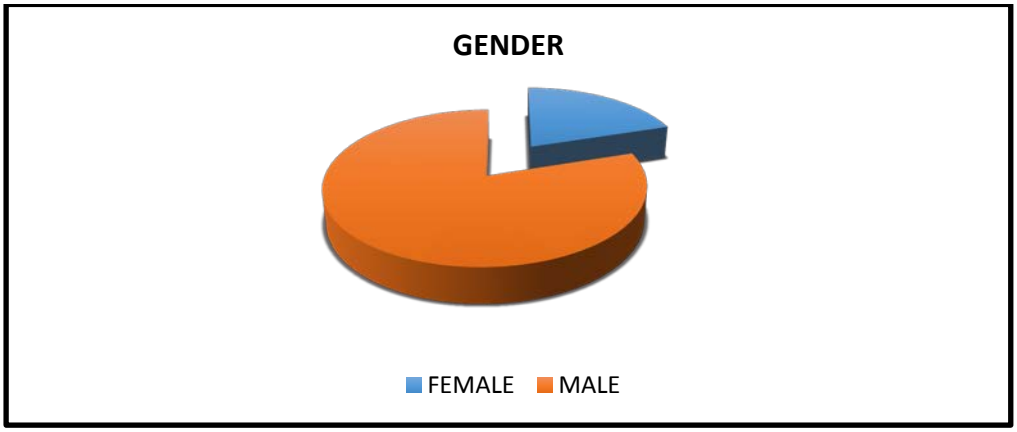
Weight bearing walking started from 10 to 16 weeks depending on the clinical and radiological signs of union.

OBSERVATION AND RESULTS

SEX:

TABLE 1:

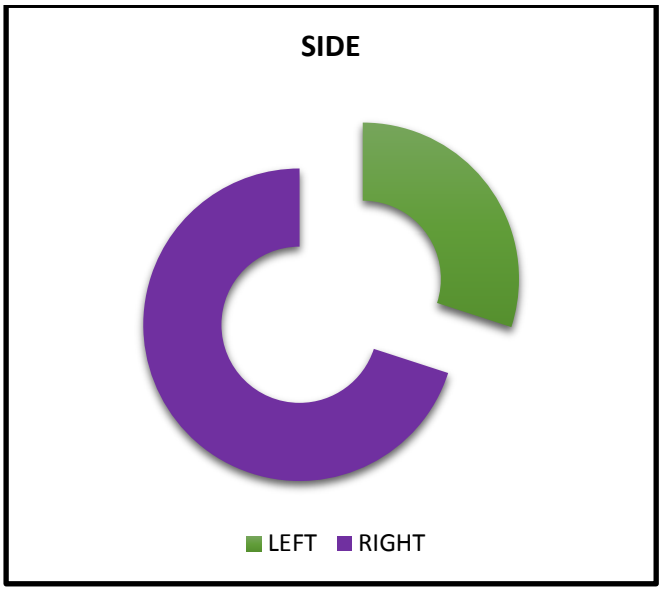
	FREQUENCY	PERCENT
FEMALE	4	20
MALE	16	80
TOTAL	20	100



SIDE:

TABLE 2:

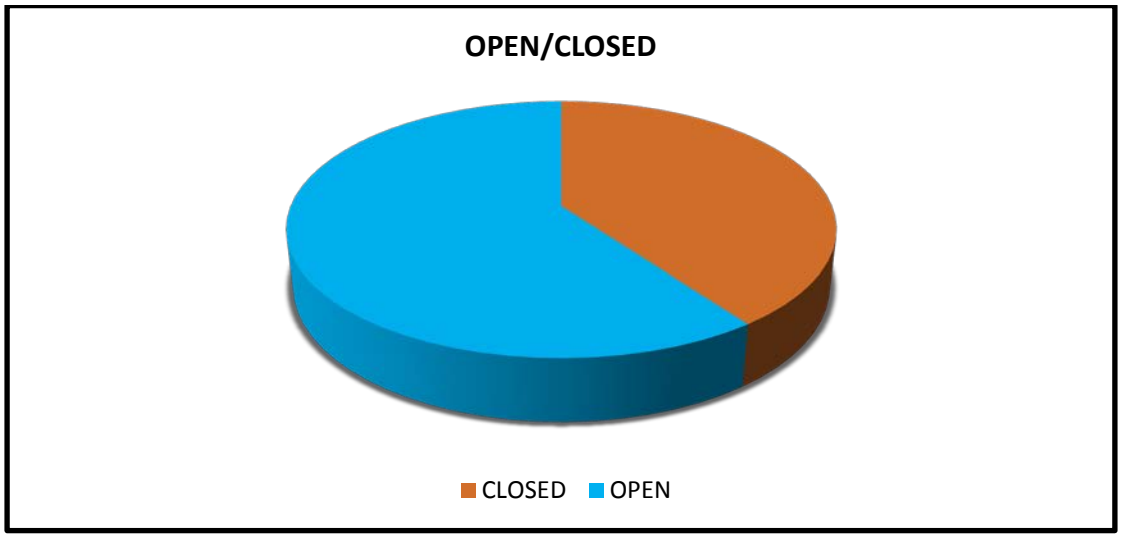
	FREQUENCY	PERCENT
LEFT	6	30
RIGHT	14	70
TOTAL	20	100



NATURE OF INJURY:

TABLE 3:

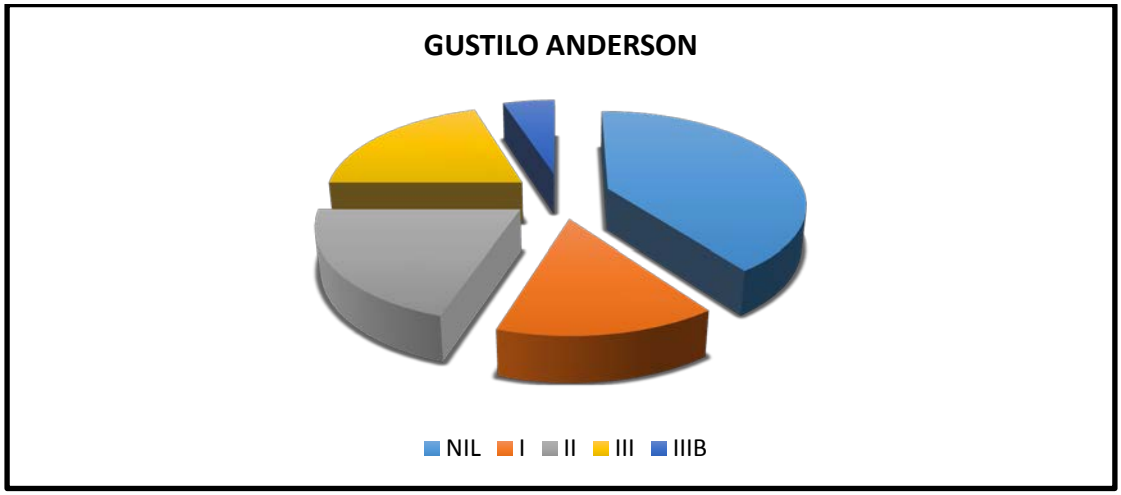
	FREQUENCY	PERCENT
CLOSED	8	40
OPEN	12	60
TOTAL	20	100



GUSTILO ANDERSON:

TABLE 4:

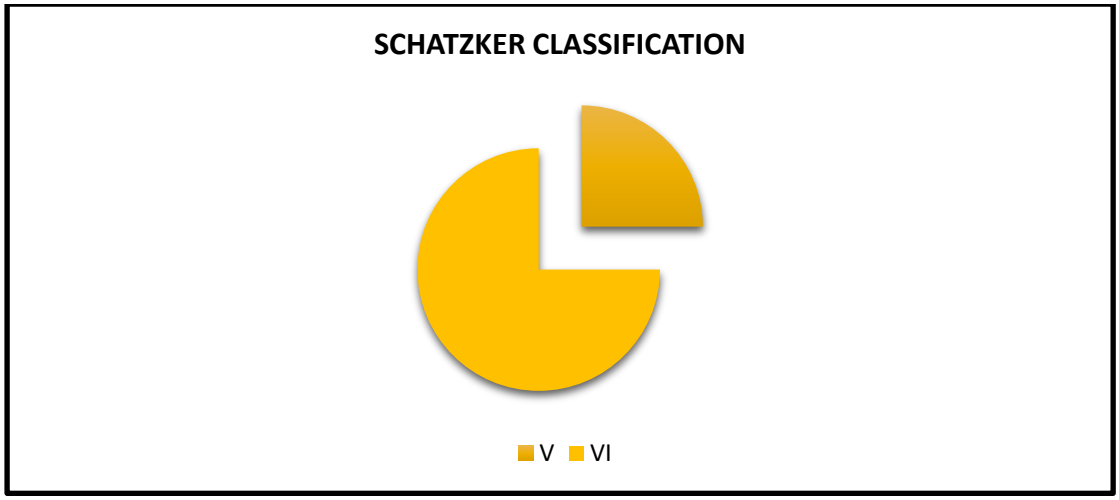
TYPE	FREQUENCY	PERCENT
NIL	8	40
I	3	15
II	4	20
IIIA	4	20
IIIB	1	5
TOTAL	20	100



SCHATZKER CLASSIFICATION:

TABLE 5:

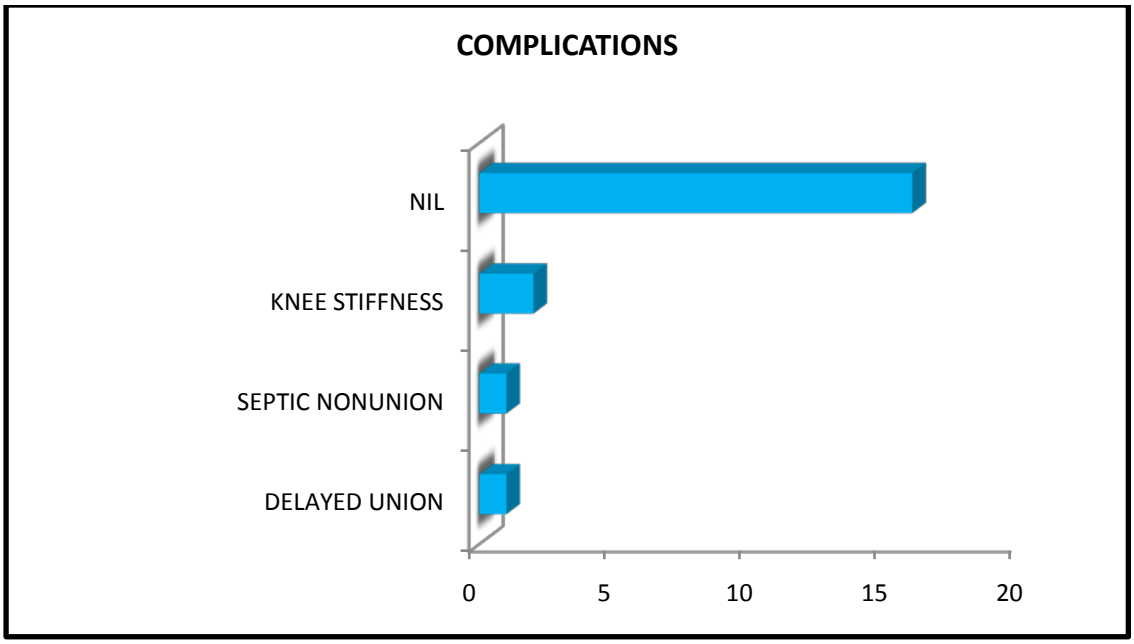
TYPE	FREQUENCY	PERCENT
V	5	25
VI	15	75
TOTAL	20	100



COMPLICATIONS:

TABLE 6:

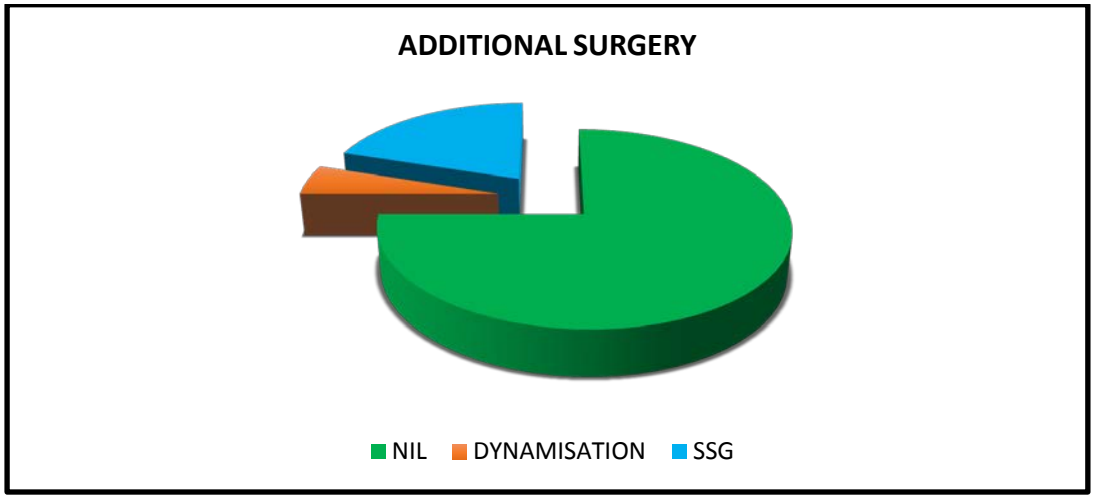
	FREQUENCY	PERCENT
NIL	15	80
KNEE STIFFNESS	2	10
DELAYED UNION	1	5
SEPTIC NONUNION	1	5
TOTAL	20	100



ADDITIONAL SURGERY:

TABLE 7:

	FREQUENCY	PERCENT
NIL	15	75
DYNAMISATION	1	5
SSG	4	20
TOTAL	20	100



RESULTS:

TABLE 8:

	FREQUENCY	PERCENT
EXCELLENT	**10**	**50**
GOOD	**7**	**35**
FAIR	**2**	**10**
POOR	**1**	**5**
TOTAL	**20**	**100**

RASMUSSEN KNEE SCORE

FUNCTIONAL SCORE:

1. **PAIN:**
- No pain 3
- Minimal pain during activity 2
- Constant severe pain even at rest 1

2. **LIMITATION OF ACTIVITY:**
- Unlimited activity 3
- Limitation of activity especially sports 2
- Greatly diminished activities 1

3. **RANGE OF MOTION:**
- < 10 degree limitation of flexion 3
- < 30 degree limitation of flexion 2
- > 30 degree limitation of flexion 1

4. **QUADRICEPS POWER:**
- No loss of quadriceps strength 3
- 30-45% derease in strength 2
- Greater than 45% decrease in strength 1

RADIOLOGICAL SCORE:

5. **ARTICULAR DEPRESSION:**
- None 3
- < 5mm 2
- 6 – 10mm 1
- >10mm 0

6. **CONDYLAR WIDENING:**
- None 3
- < 5mm 2
- 6 – 10mm 1
- >10mm 0

7. **VARUS/VALGUS ANGULATION :**
- None 3
- < 10 degrees 2
- 10-20 degrees 1
- >20 degrees 0

8. OSTEOARTHRITIS

- None 1
- Progression by grade 1 0
- Progression by grade>1 -1

GRADING ACCORDING TO SCORE

Excellent	9-10
Good	7-8
Fair	5-6
Poor	<5

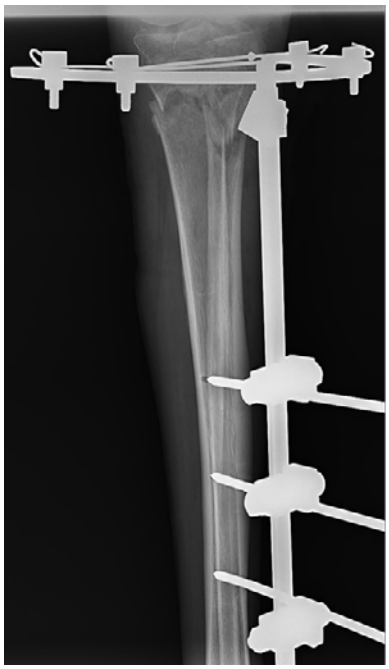
CASE ILLUSTRATION

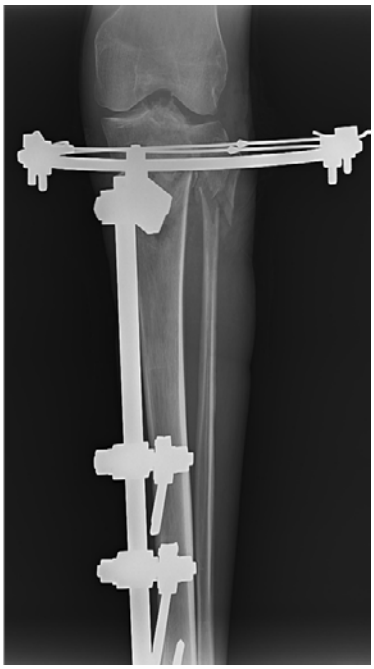
CASE I:

NAME	**Mr.MANOHAR**
AGE	**54 YEARS**
SEX	**MALE**
MODE OF INJURY	**RTA**
SIDE	**LEFT**
SCHATZKER TYPE	**VI**
ASSOCIATED INJURY	**NIL**
TIME INTERVAL BETWEEN INJURY AND SURGERY	**3 Days**
RADIOLOGICAL UNION	**4 months**
RANGE OF MOVEMENTS	**Full** **Flexion: 0- 120 degrees**
RASMUSSEN KNEE SCORE	**21**
COMPLICATIONS	**NIL**
RESULT	**EXCELLENT**

PRE OP

IMMEDIATE POSTOP





3 MONTHS FOLLOW UP

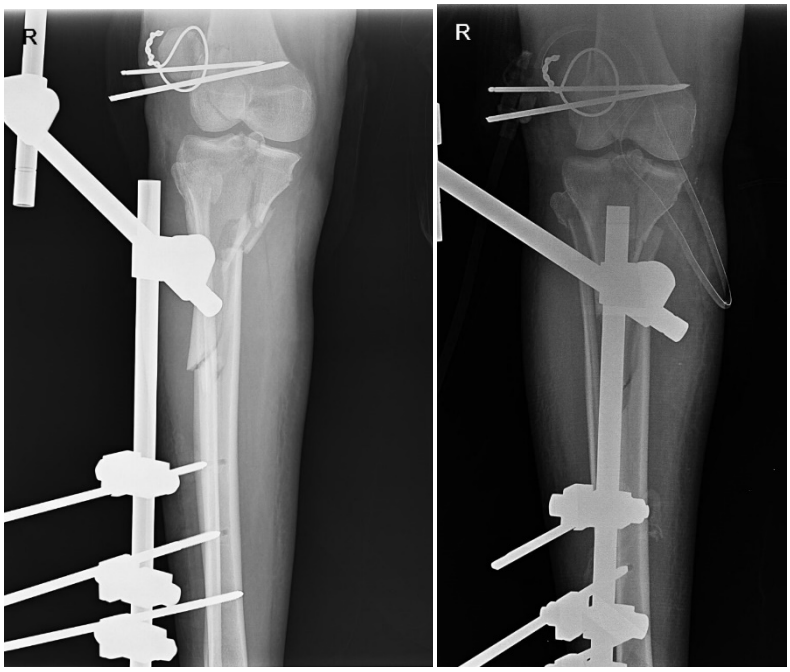
4 MONTHS FOLLOWUP

CASE II

NAME	**Mrs.MAMTHA**
AGE	**28 YEARS**
SEX	**FEMALE**
MODE OF INJURY	**RTA**
SIDE	**RIGHT**
SCHATZKER TYPE	**VI**
ASSOCIATED INJURY	**PATELLA FRACTURE**
TIME INTERVAL BETWEEN INJURY AND SURGERY	**4 days**
RADIOLOGICAL UNION	**4 months**
RANGE OF MOVEMENTS	**Full** **Flexion: 0 – 90 degrees**
RASMUSSEN KNEE SCORE	**18**
COMPLICATIONS	**NIL**
RESULT	**EXCELLENT**

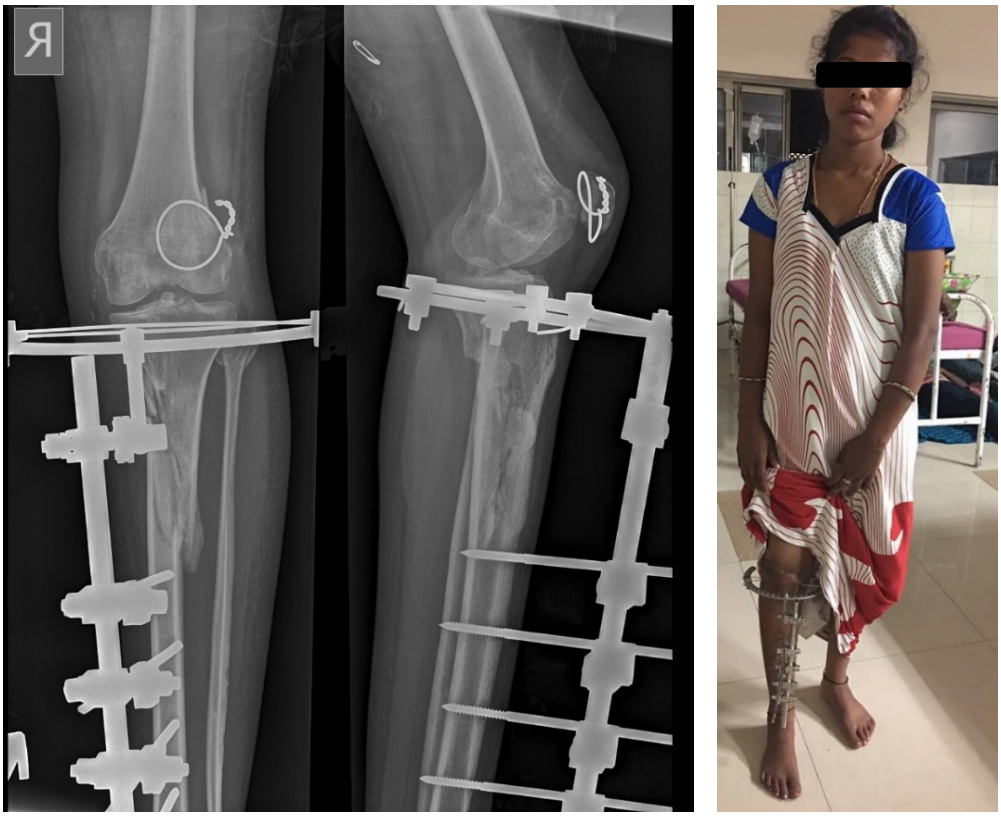
PRE OP

EMERGENCY EXTERNAL FIXATOR



IMMEDIATE POST OP

3 MONTHS POST OP



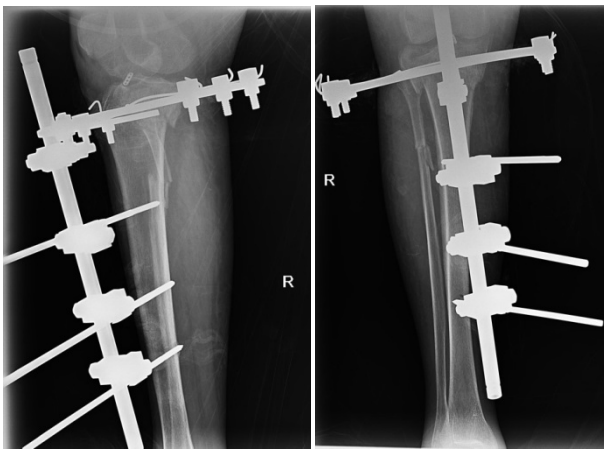
4 MONTHS POST OP

CASE III

NAME	**Mrs.Palaniyammal**
AGE	**70 years**
SEX	**Female**
MODE OF INJURY	**RTA**
SIDE	**Right**
SCHATZKER TYPE	**VI**
ASSOCIATED INJURY	**NIL**
TIME INTERVAL BETWEEN INJURY AND SURGERY	**30 days**
RADIOLOGICAL UNION	**5 months**
RANGE OF MOVEMENTS	**Full** **Flexion: 0 – 110 degrees**
RASMUSSEN KNEE SCORE	**20**
COMPLICATIONS	**NIL**
RESULT	**Excellent**

PREOP

IMMEDIATE POST OP



3MONTHS FOLLOW UP

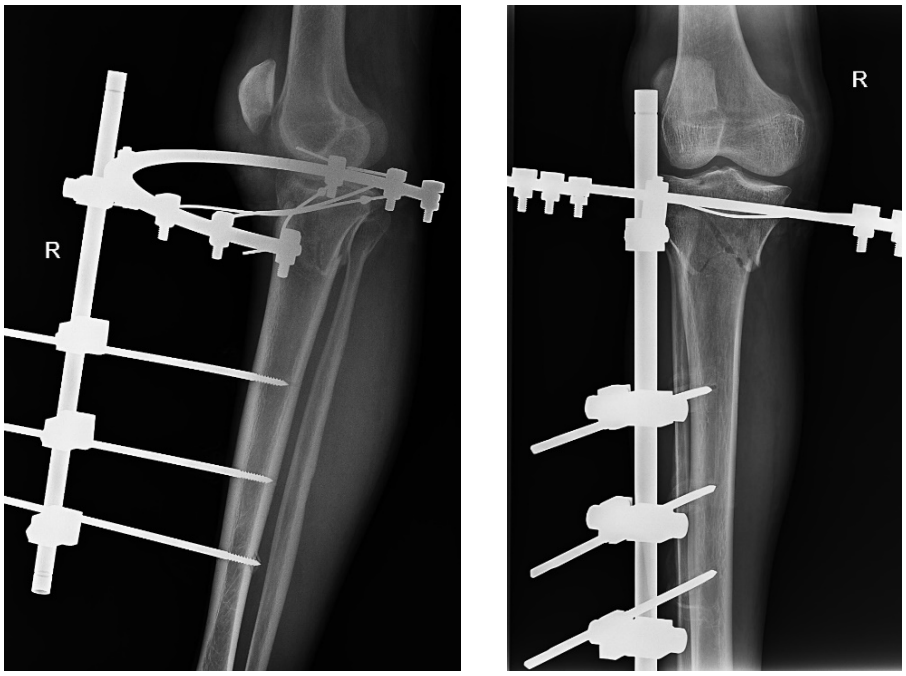
5MONTHS FOLLOW UP

CASE IV

NAME	**SUBRAMANI**
AGE	**54/M**
SEX	**MALE**
MODE OF INJURY	**RTA**
SIDE	**RIGHT**
SCHATZKER TYPE	**V**
ASSOCIATED INJURY	**NIL**
TIME INTERVAL BETWEEN INJURY AND SURGERY	**0**
RADIOLOGICAL UNION	**4 MONTHS**
RANGE OF MOVEMENTS	**100 DEGREES**
RASMUSSEN KNEE SCORE	**19**
COMPLICATIONS	**NIL**
RESULT	**EXCELLENT**

PRE OP

IMMEDIATE POSTOP



3 MONTHS FOLLOWUP

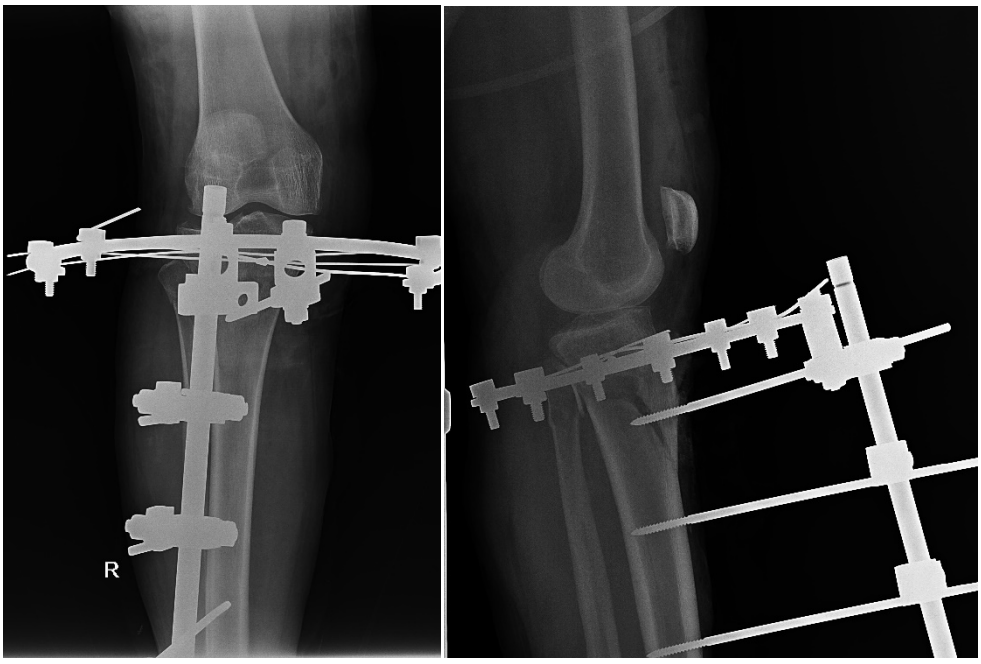
5 MONTHS FOLLOW UP

CASE V

NAME	**ANANDHAVEL**
AGE	**39**
SEX	**MALE**
MODE OF INJURY	**RTA**
SIDE	**RIGHT**
SCHATZKER TYPE	**V**
ASSOCIATED INJURY	**NIL**
TIME INTERVAL BETWEEN INJURY AND SURGERY	**7 DAYS**
RADIOLOGICAL UNION	**4 MONTHS**
RANGE OF MOVEMENTS	**90 DEGREE**
RASMUSSEN KNEE SCORE	**15**
COMPLICATIONS	**NIL**
RESULT	**GOOD**

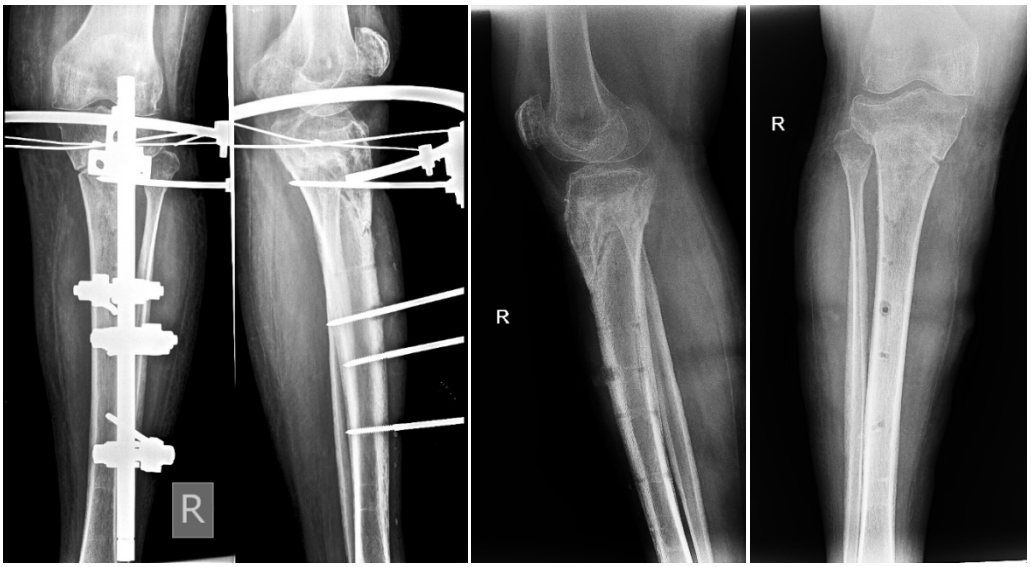
PRE OP

IMMEDIATE POST OP



3 MONTHS FOLLOW UP

4 MONTHS POST OP



COMPLICATIONS

	FREQUENCY	PERCENT
NIL	16	80
KNEE STIFFNESS	2	10
DELAYED UNION	1	5
SEPTIC NONUNION	1	5
TOTAL	20	100

Two patients developed knee stiffness since they did not follow the postop protocol and rehabilitation exercises.

PRE OP **IMMEDIATE POST OP**

4 MONTHS POST OP

One patient developed septic non-union and diabetic cellulitis of thigh and leg. He recovered with wound debridement, higher antibiotic coverage and SSG.

PREOP **IMMEDIATE POST OP**

3 MONTHS POST OP

6 MONTHS POST OP

DISCUSSION

Schatzker type V and VI tibial plateau fractures are due to high energy trauma which is considered as a major cause of poor results. Mostly these fractures are associated with extensive soft tissue damage and compartment syndrome.

Different methods for treating these complex injuries have been proposed, including limited open reduction and stabilisation with percutaneous screws, open reduction and internal fixation and indirect reduction and application of external fixator, ring fixator or hybrid external fixator.

Traction, inturns of ligamentotaxis and casting, produces improper articular surface reduction, lacks the necessary stability, leading to varus/ valgus deformity, collapsed articular surface and post immobilisation stiffness[10-13]Tscherne et al, in a study comparing the results of surgical and conservative groups , reported good range of motion due to early mobilisation, reduced reoperation rate ,varus/valgus angulation and malunion for the operated group.

Open surgical procedures provides good articular reduction, but do not protect the already damaged soft tissue envelope[14-15] leading to skin or muscle necrosis, devascularisation of fracture fragments thereby causing delayed healing and wound complications with high rates of

infection. In a series of dual plating for bicondylartibial plateau fractures by Young and Barrack, they reported 88% of deep infection rate. In a study comparing the lateral plating and dual plating conducted by Jiang R et al, there was no significant difference between the two groups.

The external fixation is considered as the definitive treatment for the polytrauma patient with multiple osseous injuries associated with soft tissue compromise. But it often leads joint stiffness due to delayed mobilisation of knee joint. Certain surgeons believed that the use of external fixation should be limited to high energy tibial plateau fractures. But in the past two decades, the evolution of new external fixator devices and techniques has led many surgeons to apply the external fixators to comminutedtibial plateau fractures[16-19]. The development of circular and hybrid frames, the capability of axial, lateral compression and dynamisation, the development of olive wires have led new possibilities of treating complex tibial plateau fractures with soft tissue damage[20].

In a study comparing the external and internal fixation by Mahadena et al, he concluded that hybrid external fixation provides theoretical advantages in terms of soft tissue protection[21].

In our study, The mean age of the patient at the time of injury was 47.50 years (range 23-70 years). Comparing to the similar study of

modified hybrid fixator for high energy schatzker V and VI tibial plateau fractures conducted by Ariffin et al the mean age was almost the same.

STUDY	Mean age(in years)
Ariffin et al	44
Our study	47.5

Male predominance was seen (80%) and it was contributed to the increased usage of motor vechicles by men. 70 % had right sided injury. Among the 20 patients, 12 patients (60%) sustained open injury. Comparing to a similar study of high energy tibialpalteu fractures treated with hybrid external fixation conducted by Babis et al,our study has higher rate of open fractures

STUDY	OPEN FRACTURE	CLOSED FRACTURE
BABIS ET AL	18.18%	81.81%
OUR STUDY	60%	40%

Among the 12 patients who had open fractures with soft tissue injury,3 patients had type I Gustilo Anderson injury, 4 patients had type II Gustilo Anderson injury, 4 patients had type IIIA Gustilo Anderson injury, 1patient had type IIIB Gustilo Anderson injury. For these patients, after hybrid fixation, wound management was carried with regular

dressing, higher antibiotics, wound debridement. One patient with type IIIA and one patient with type IIIB soft tissue injury needed skin cover and SSG done on a later date. For one patient with compartment syndrome, fasciotomy with hybrid external fixation done and later SSG done for the fasciotomy wound. One patient developed septic non union and developed abscess over the thigh and leg which was treated with abscess drainage and thorough debridement and higher antibiotics according to the pus culture and sensitivity.SSG done for this patient on a later date.

In our study 15 out of 20 patients (75%) had schatzker type VI tibial plateau fracture. The remaining five patients had type V tibial plateau fracture.in a similar study conducted by Babis et al he quoted almost equal amount of type V and VI fractures.

STUDY	TYPE V FRACTURE	TYPEVI FRACTURE
BABIS ET AL	48.48%	51.51%
OUR STUDY	25%	75%

The average duration of hospital stay after surgery was 8.20 days (range 3-18days). The mean interval between the time of injury and time of surgery was 5.55 days (range 0-30) days. The mean duration of

surgery was 66.55 min (range 55-90) min. All fractures (19 out of 20) united in an average time of 18 weeks (16- 25 weeks). The external fixator was tolerated for the entire treatment period in all cases.one fracture(5%) took longer than six months to heal.in similar studies conducted by Babis et al and Ariffin et al,they quoted the average union at 14 weeks which was four weeks earlier comparing to our study.However we feel that the delay in union was acceptable since we encountered more of open fractures and type VI tibial plateau fractures

STUDY	AVERAGE TIME OF UNION IN WEEKS
BABIS ET AL	14
ARIFFIN ET AL	14
OUR STUDY	18

Chin et al presented 38.9%good/excellent, and 61.1%fair/poor results in his type V and VI tibial plateau fractures[22]. Katsenis et al recorded 76% excellent/ good final clinical results[23]. Catagni et al reported 50.85% excellent and 45.76% good results[24].we noted that the results were almost similar in similar studies conducted by Ariffin et al and Babis et al(85% excellent/good and 15% fair/poor)

STUDY	EXCELLENT/GOOD	FAIR/POOR
CHIN ET AL	38.9%	61.1%
KATSENIS ET AL	76%	24%
CATAGNI ET AL	96.61%	3.39%
ARIFFIN ET AL	90%	10%
BABIS ET AL	85%	15%
OUR STUDY	85%	15%

According to the Rasmussens knee score the results were evaluated as excellent in 10 patients(50%) ,good in 7 patients (35%),fair in 2 patients(10%) and poor in 1 patient(5%). Comparing to similar study done by chin et al we had 50% better outcome in excellent / good group and 10% better outcome in excellent/good group comparing to similar

study done by katsenis et al and 10% less outcome in excellent/good group comparing to similar study by catagni et al.

In our study,a total of 19 patients regained functional use of the knee joint, good axis without pain or instability. Patient's knee ROM was gradually increasing at consecutive clinical evaluations. After one year follow up the knee ROM ranged from 30º to 130º with an average knee ROM of 102.5º.in similar studies conducted by Babis et al and Ariffin et al,the average ROM was reported as 115º.reduced functional outcome in our study was acceptable and attributed tothe more compound fractures, more type VI fractures and poor compliance of two patients to the rehabilitation exercises. Moreover two patients had associated injuries like patella fracture and shaft of femur fracture and two patients.

STUDY	ROM IN DEGREES
BABIS ET AL	115
ARIFFIN ET AL	120
OUR STUDY	102.5

In a multicentre, prospective, randomized clinical trial of type V and VI fractures treated by internal and external fixation, Canadian Orthopaedic Trauma Association reported similar osseous reduction and

ROM for both groups but lower rate of early postoperative complications and improved HSS score for external fixator group at the six months follow up[25].

In many older articles, authors don't breakdown their complication rate according to the type of tibial plateau fractures[16,26,27]. Covall et al treated 32 tibialbicondylar fractures during a 7 year period and reported 42% deep infection rate for the patients treated with internal fixation[28].

In our study, 2 patients developed knee stiffness.delayed union was encountered in one patient, It was treated with dynamisation of the hybrid external fixator and improved . One fracture was complicated with deep infection and diabetic cellulitis leading to septic non-union(5%).the patient with septic non union was treated with surgical debridement and higher antibiotics until CRP and ESR reached normal values and he is on further follow up.

Overall 4 patients(20%) faced with complications including knee stiffness,delayed union and septic non union. Infection was the main drawback when using the external fixator for treating fractures.

Hutson et al , in a meta-analysis of 16 studies with a total 568 patients found pin site infection rates of 10%[29].

STUDY	PIN TRACK INFECTION	DEEP INFECTION	SEPTIC ARTHRITIS
HUTSON ET AL	10%	4%	1%
BABIS ET AL	9.1%	3%	NIL
ARIFFIN ET AL	25.80%	NIL	3.22%
OUR STUDY	15%	5%	NIL

Our rate of pin track infection was encountered in 3 patients. These infections were superficial or limited to the soft tissue and did not extend to the bone. None of the patients required hospital admission.These were treated with oral antibiotic and local pin care. All pin care infections healed without requiring wire or half pins removal that could compromise frames stability. The rate of septic arthritis was also nil.The septic arthritis is a rare complication arising from the faulty use of the technique and is related to the placement of wires in the capsular reflection of the knee joint. This was safely avoided in our study by placing the proximal most wires 14 mm below the joint line. The rate of deep infection was 5% which was almost similar to the previous

studies. However we feel that in this patient this was attributed to the improper pin track care and the comorbid condition of the patient since the patient was known diabetic.

Complications concerning the external fixator like intolerance or pin loosening were not observed in our study.

LIMITATIONS

The disadvantages include the need for constant pin care, pin site infection and the risk of septic arthritis from incidental intra capsular pin placement. This can be safely avoided by placing the proximal most wires 14mm below the joint line[31].

As limitations of this study, one should consider its shortterm follow up. This follow up was inadequate to draw safe conclusion about the post traumatic osteoarthritis. This report may be the basis for a new study examining the development of post traumatic osteoarthritis in high energy tibial plateau fractures.

CONCLUSIONS

The degree of soft tissue involvement in tibial plateau fractures is an important determinant not only for the choice of treatment modality but also for the final outcome.Schatzker type V and VI tibial plateau fractures represent serious injuries with substantial limb specific and general health deficits[25]. While confronting such life threatening limb injuries, hybrid external fixation successfully provided continuous access on the surrounding tissues as well as proper osseous stabilisation without compromising the sensitive soft tissue envelope.

Modified hybrid external fixator is a safe and effective choice for treating high energy tibial plateau fractures. It reduces the soft tissue complications and improves bony union with acceptable reduction and favourable outcome. It allows early mobilisation of the patient.The complications are mainly related to sepsis either superficial pin track infection or deep infection which are preventable, treatable and curable. We feel that the technique merits a place in the armamentarium for managing complex high energy tibial plateau fractures.

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ANNEXURE – I

PROFORMA

Name	Case No :
Age	IP/OPNo :
Sex	Date Of Admission :
Address	Date Of Surgery :
Occupation	Date Of Discharge :

Diagnosis

Chief Complaints

History of Presenting Illness

Mode of Injury

Past History

Family History

Personal History

General Physical Examination

Vital Signs	Systemic Examination
BP	CVS
RR	RS
PR	CNS
Temp	Per Abdomen

LOCAL EXAMINATION

Inspection – attitude,Swelling,Deformity,Wound,Others

Palpation – Local Rise of Temperature,Tenderness,Abnormal Mobility,Crepitus

Measurements :Length Of The Leg Right Left

Movements – Knee – Flexion /Extension

Distal Pulses :

DorsalisPedis

Posterior Tibial

Sensory Disturbance

Motor function

Associated injuries

INVESTIGATIONS :

Blood

Haemoglobin

Total count

Differential count

Erythrocyte sedimentation rate

Random blood sugar

Blood urea

Serum creatinine

HIV

HBsAg

HCV

VDRL

Urine routine

Albumin

Sugar

ECG

Radiology :

X ray knee with leg AP and lateral

X ray leg with ankle AP and lateral

TREATMENT

Preoperative

Above knee plaster of paris slab

Analgesics

SURGICAL PLANNING :

Type of anaesthesia

Duration of surgery

Tourniquet time

Additional procedures

POST OPERATIVE :

Intravenous fluids

Antibiotics

Check x rays

ASSESSMENT OF RESULTS

Pin site infection

Malunions,non union , delayed union

Nerve injuries

Knee stiffness

Follow up visits

Time of visit	Radiographs(to assess union)	Knee ROM(flexion and extension)	Complications
6 weeks			
3 months			
6 months			
1 year			

ANNEXURE – II

CONSENT FORM

I _____ Hospital No. _____ in my full consciousness, hereby give my complete consent for _____ or any other procedures deemed fit which is a (diagnostic procedure/biopsy/transfusion/surgery) to be performed on me /my son /my daughter/my spouse-_____ of Age __ under any anaesthesia which is suitable for the procedure. The nature and risks involved in the procedure have been explained to me clearly. The procedure may be recorded and can be used for research purposes

Date: Signature/ Thumb impression

Of Patient/Guardian

Name and designation of guardian

Relationship with full address

SL.NO	NAME	AGE/SEX	IP NO	DOA	MODE OF INJURY	SIDE	OPEN/ CLOSED	GUSTILO ANDERSON	SCHATZKER CLASSIFICATION	EMERGENCY EXTERNAL FIXATOR	INTERVAL DAYS	DURATION OF SURGERY (MIN)	DAYS IN HOSPITAL	RADIOLOGICAL UNION(MONTHS)	COMPLICATIONS	FIXATOR REMOVAL(MONTHS)	ADDITIONAL SURGERY	FLEXION ROM	EXTENSOR LAG	FUNCTIONAL SCORE	RADIOLOGOCAL SCORE	RESULTS
1.	SEKAR	42/M	78298	25.12.15	RTA	RIGHT	CLOSED	-	VI	DONE	7	60	5	4	NIL	4	-	130	-	12	9	EXCELLENT
2.	PALANIYAMMAL	70/F	20230	12.03.16	RTA	RIGHT	CLOSED	-	VI	-	30	90	7	5	NIL	5	-	120	-	11	9	EXCELLENT
3.	PERIYAKKA	70/F	21158	05.04.16	RTA	RIGHT	CLOSED	-	VI	DONE	15	70	7	5	NIL	5	-	120	-	11	8	EXCELLENT
4.	SEVI	65/M	37049	10.02.16	RTA	LEFT	CLOSED COMPART SYND	-	VI	-	0	55	3	6	NIL	6	SSG	120	-	10	8	EXCELLENT
5.	VEERAPRAKASAM	36/M	97532	03.11.15	RTA	LEFT	CLOSED	-	VI	-	1	65	7	4	NIL	5	-	120	-	10	8	EXCELLENT
6.	MAKIMAINATHAN	62/M	65438	30.12.15	RTA	RIGHT	OPEN	III	VI	-	5	55	15	4	NIL	4	-	100	-	8	7	GOOD
7.	MANOHAR	54/M	36793	06.06.16	RTA	LEFT	OPEN	II	VI	-	3	65	5	4	NIL	4	-	130	-	12	9	EXCELLENT
8.	MURUGESAN	23/M	9380	15.02.16	RTA	RIGHT	OPEN	III	V	-	2	75	17	6	PIN TRACK INFECTION	6	-	110	-	11	9	EXCELLENT
9.	SHAJAHAN	52/M	34967	26.07.16	RTA	RIGHT	OPEN	II	VI	-	3	65	12	6	NIL	6	-	110	-	8	7	GOOD
10.	ANANDHAVEL	39/M	48316	29.08.16	RTA	RIGHT	OPEN	I	V	-	7	70	05	4	NIL	4	-	100	-	8	7	GOOD
11.	KANDHASAMY	63/M	45972	06.07.16	RTA	LEFT	OPEN	II	VI	-	6	75	10	6	NIL	6	-	100	-	7	7	GOOD

12.	MAMTHA	28/F	40321	23.10.16	RTA	RIGHT	OPEN	III	VI	DONE	4	60	10	4	PIN TRACK INFECTION	4	-	100	-	10	8	EXCELLENT
13.	MATHI	36/M	25846	15.10.16	RTA	LEFT	OPEN	III	V	DONE	7	60	11	5	NIL	5	SSG	100	10	8	7	GOOD
14.	PALANISAMY	60/M	17985	18.03.17	RTA	RIGHT	OPEN	I	VI	-	4	65	5	5	KNEE STIFFNESS	5	-	30	-	6	6	FAIR
15.	NAGARAJ	35/M	19993	26.03.17	RTA	RIGHT	OPEN	II	VI	-	0	75	7	4	NON UNION	4	DYNAMISATION	120	-	11	9	EXCELLENT
16.	SARAVANAN	30/M	16724	13.03.17	RTA	LEFT	OPEN	IIIB	VI	-	0	60	18	4	NIL	4	SSG	100	-	8	8	GOOD
17.	MURUGAN	27/M	23927	10.04.17	RTA	RIGHT	CLOSED	-	V	-	5	65	5	5	PIN TRACK INFECTION	5	-	100	-	7	8	GOOD
18.	SUBRAMANI	54/M	21367	03.03.17	RTA	RIGHT	OPEN	I	V	-	0	60	5	4	NIL	4	-	120	-	10	9	EXCELLENT
19.	PERIYANNAN	50/M	48496	27.07.16	RTA	RIGHT	CLOSED	-	VI	-	7	80	5		SEPTIC NONUNION		SSG	90	-	4	5	POOR
20.	LALITHA	24/F	25412	25.04.17	TTA	RIGHT	CLOSED	-	VI	-	5	60	5	4	KNEE STIFFNESS	5	-	30	-	6	6	FAIR